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ABSTRACT

In this journal issue, articles examine various aspects of measuring creativity, productivity of gifted individuals, fostering psychological well-being of the gifted, and federal funding of gifted programs. Specific articles include: (1) "The Death of Creativity Measurement Has Been Greatly Exaggerated: Current Issues, Recent Advances, and Future Directions in Creativity Assessment" (Jonathan A. Plucker and Mark A. Runco), which reviews some of the current concerns about creativity measurement such as fluency as a contaminating factor and content generality-specificity, and notes recent advances in the predictive validity of divergent thinking tests; (2) "A Statistical Analysis or Special Cases of Creativity" (John C. Huber), which discusses findings that indicate creative individuals exhibit random outputs over time and follow the Poisson distribution, that creative people are intrinsically motivated, and that environmental effects are small; (3) "State of Excellence" (David Lubinski and Camilla Persson Benbow), which shows how theory of work adjustment concepts and psychometric methods, when used together, can facilitate positive development among talented youth by aligning learning opportunities with salient aspects of each student's individuality; (4) "The Javits Gifted and Talented Students Education Program: Background and Funding" (Susan Boren), which describes the history of this federal program and legislative proposals to expand it. (Most articles include references.) (CR)

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Measuring Creativity.

Phyllis Miller, Editor

Mensa Research Journal 46
Volume 32, Number 1

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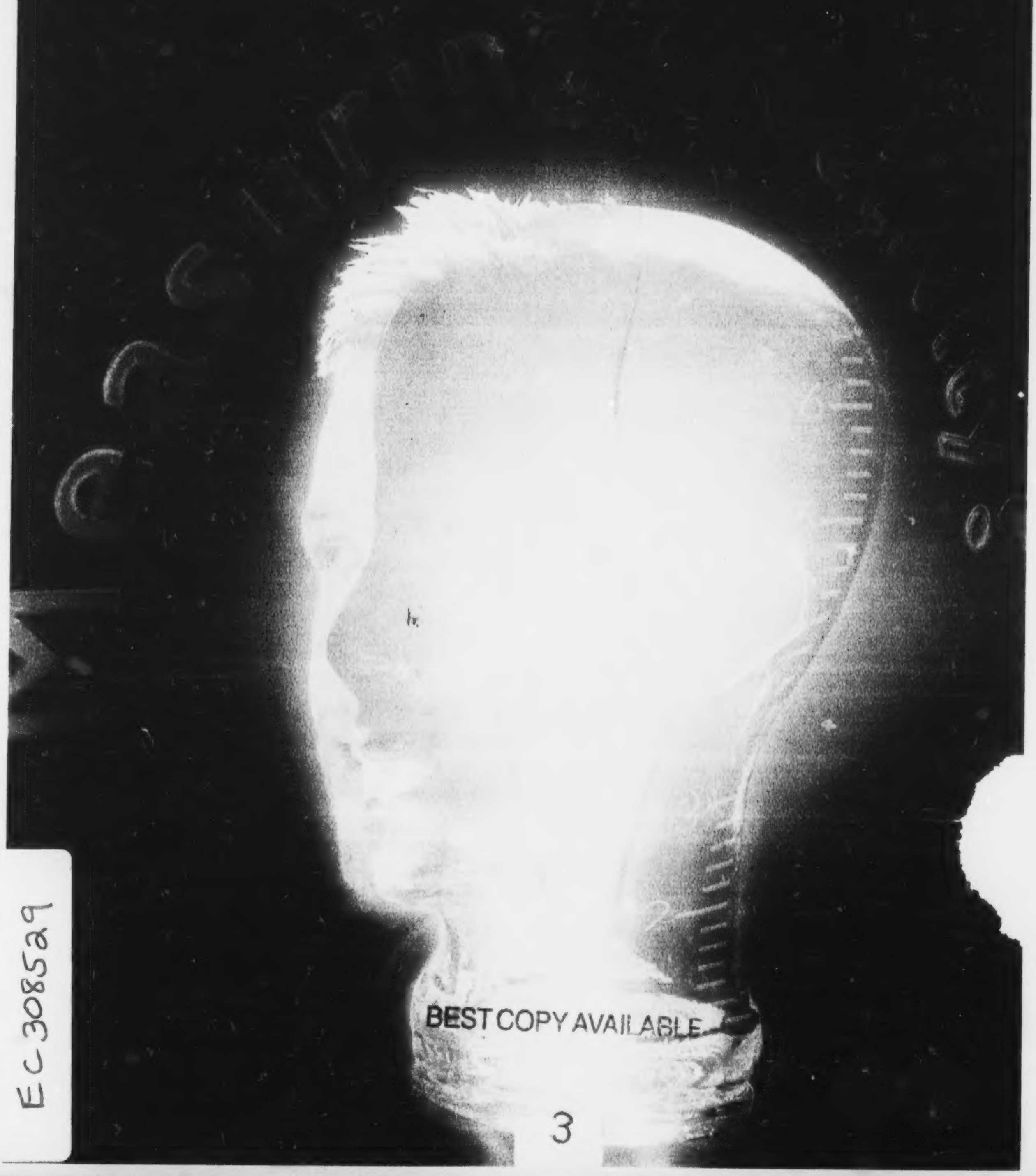

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The Mensa Education & Research Foundation

Mensa, the high IQ society, provides a meeting of the minds for people who score in the top 2 percent on standardized IQ tests. As an international organization with thousands of members worldwide, Mensa seeks to identify and foster human intelligence; encourage research in the nature, characteristics and uses of intelligence; and provide a stimulating intellectual and social environment for its members.

The first two of these purposes are largely carried out by the Mensa Education & Research Foundation (MERF). MERF is a philanthropic, nonprofit, tax-exempt organization funded primarily by gifts from Mensa members and others. MERF awards scholarships and research prizes, publishes the *Mensa Research Journal,* and funds other projects consistent with its mission.

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Associate Editor's Preface

Regular readers of *MRJ* will notice that we have changed our issue numbering system. In the past, issues were numbered sequentially so that this would have been numbered only as *MRJ* #46. To conform to the system of most periodicals, we will now begin to use a volume and number. *MRJ* began in 1969, so this issue is numbered Vol. 32, No. 1.

A reminder: When Phyllis Miller, editor of *Mensa Research Journal*, appointed me associate editor and put me in charge of one issue a year, we planned to do a few things differently in the issues I edit. Ordinarily, each issue of *MRJ* has been devoted to reprinting research reports that were submitted in MERF's international competition for Awards for Excellence in Research. That will continue. However, in one issue each year, we deviate from that policy somewhat and may also publish original articles and reprint book reviews, bibliographies, abstracts of research reports, and other kinds of items.

Remember, all opinions expressed in *Mensa Research Journal* are those of the writers, not of MERF or Mensa.

Your advice about the *MRJ* is eagerly sought in a reader survey at the back of this issue. We want to make every issue as valuable to you as we can make it.

Francis Cartier
Associate Editor

Notes, Quotes, and Anecdotes

- Can that peculiar aspect of giftedness called creativity be measured? Opinion is sharply divided. It shouldn't be, because the answer is Yes and No. Much depends on which definition of creativity you subscribe to, e.g., whether you mean exhibited creativity or potential creativity or whatever. For an extensive exploration of definitions of creativity, see Howard B. Parkhurst, "Confusion, lack of consensus, and the definition of creativity as a construct," *The Journal of Creative Behavior*, 33, 1, First Quarter 1999.

- In this issue of *MRJ* we explore a few of the many questions about measuring creativity. The article by Plucker and Runco reprinted here was published in *Roeper Review*, 21,1. Several of their references were then listed as "in press." At my request, Dr. Plucker has provided some updates:

Plucker, J. (1998) Beware of simple conclusions: The case for generality of creativity. *Creativity Research Journal*, 11, 179-182.

Plucker, J. (1999). Is the proof in the pudding? Reanalyses of Torrance's (1958 to present) longitudinal study data. *Creativity Research Journal*, 12, 103-114.

Plucker, J. (1999). Reanalyses of student responses to creativity checklists: Evidence of content generality. *Journal of Creative Behavior*, 33, 126-137.

Plucker, J., & Renzulli, J. S. (1999). Psychometric approaches to the study of human creativity. In R. J. Sternberg (Ed.). *Handbook of Creativity* (pp. 35-60). New York: Cambridge University Press.

Plucker and Runco (in press) became: Runco, M. A., Plucker, J., & Lim, W. (in press) Development and psychometric integrity of a measure of ideational behavior. *Creativity Research Journal*.

- Another Plucker article that may interest you is "Alcohol, tobacco, and marijuana use: Relationships to undergraduate students' creative achievement," *Journal of College Student Development*, September/October 1998, pp. 472-481. The research they refer to on smoking and creativity is "complex and contradictory." Marijuana can have a positive influence on some kinds of creativity but had negative effects, too, such as "slowed reaction time during associative tasks, decreased text comprehension, and degraded short-term memory." The history of alcohol use by creative people is extensive but difficult to interpret. They report their own study of 176 college students the results of which "do not provide definitive evidence either supporting or refuting" the earlier research. "Taken collectively, the current study and previous research provide almost no support for the belief that drug use has either a short-term or long-term beneficial effect on creativity. To the contrary, the effect may be quite negative." Dr. Plucker tells me you can get a reprint from Jonathon A. Plucker, Indiana University, 201 North Rose Ave., Bloomington, IN 47405-1006, or email him at jplucker@indiana.edu. He might even include some related articles.

- A 1998 Jossey-Bass book by John S. Dacey and Kathleen H. Lennon, *Understanding Creativity: The Interplay of Biological, Psychological, and Societal Factors*, is reviewed by Todd. J. Lubart in *Contemporary Psychology: APA Review of Books*, Oct. 2000. Dacey and Lennon propose a five-layer system with interactions between brain functions, cognitive factors, personality, family dynamics, and the work, educational and economic-political environment. Their addition of brain physiology makes their model different from previous models. I haven't seen the book and can't do justice even to the review here, but thought you might like to know about it.

- That same issue of *Contempor ıry Psychology* has a review by Mihaly Csikszentmihalyi (a name one sees often connected to research in intelligence) of a 1999 N. Y. University Press book, *A Watched Pot: How We Experience Time*. You are already familiar with several aspects: Time flies when you're having fun and drags when you're bored; the wealthier you are, the more your time is worth; different cultures feel time pressures differently; etc. The review doesn't mention whether the book examines a question I'm curious about. Do the gifted experience time differently? If you know of any research on that, let me know.

- If you are as interested as I am in definitions of intelligence, you may want to check your library for an article by Wendy M. Williams, Dept. of Human Development, Cornell. Titled "Consequences of how we define and assess intelligence," it appeared in *Psychology, Public Policy and Law*, 1996, Vol. 2, No. 3/4, pp. 506-535. Williams' critical history of IQ testing alone is thought provoking. Her research is intriguing. Warning: This is not easy reading if you're unfamiliar with quantitative research in psychology.

- Which reminds me of the report on a symposium at the 1999 convention of the American Psychological Society (not to be confused with the American Psychological Association) in *APS Observer, July/August 1999*. Under the rubric, "Science and Pseudoscience," four speakers lamented the American public's preference for, as one of my mentors once put it years ago, "The comprehensible lie rather than the incomprehensible truth." One speaker, Dr. Carol Tavris, defined pseudoscience as "the determined pursuit of confirmation of one's own belief . .. [It] wears the veneer of science but lacks its central infusing spirit of inquiry and the willingness to come up wrong." The media, of course, often go for the comprehensible lie. In September 1999, for example, there was much made of genetic manipulation of mice that made them "smarter." Confused by two conflicting press reports, I asked fellow Mensan Marilyn Watson, a biochemist, to explain it to me. She said that both press releases were inaccurate. The moral here is that we should be extremely wary of media reports of scientific research.

- The nature *vs.* nurture controversy is being enlightened somewhat by molecular biology. Bernard Brown, writing in the April 1999 issue of *Current Directions in Psychological Science*, says the question is now "how and when expression of the human genome is triggered and maintained." Like many such issues, it becomes increasingly complicated as we learn more. In a critical number of cells affecting human growth, the genetic machinery of the cell does not by itself issue instructions to assemble proteins from the genetic blueprint.

Rather, gene expression is triggered by hormones, messenger proteins secreted by endocrine glands. Hormone levels are influenced by biological and psychological environments. Brown expands at length on that statement then recommends several books as further reading, including M. C. Diamond, *The Impact of the Environment on the Anatomy of the Brain*, (New York: Free Press, 1998).

- I don't know whether it's the same person, but Marian Diamond and Janet Hopson have written a book, *Magic Trees of the Mind: How to Nurture Your Child's Intelligence, Creativity, and Healthy Emotions from Birth through Adolescence*, (New York: Plume Books, 1998j). Bruce Torf at Hofstra University reviews it in *Contemporary Psychology*, Vol. 45, No. 1, 2000. Tort has a few criticisms, e.g., that it provides less guidance for parents of adolescents than for younger kids, but praises it for felicitous combination of scientific detail and readable, even elegant, writing style. Torf says it "...includes a great many helpful do's and don'ts for parents" and "sounds the bell for child-rearing practices grounded in research-based and child-centered principles."
- Several books and pamphlets on developing creative thinking are listed in *The Creativity Catalog* published by the Creative Education Foundation, 1050 Union Road #4, Buffalo, NY 14224. Some of the items listed are more inspirational than scientific, but hey! Let's not knock inspiration, especially in this area. Write to the CEF for the free catalog.
- See *Contemporary Psychology* (now subtitled: *APA Review of Books*) August 1999, for Joan Freeman's review of the book by Reva C. Friedman and Karen B. Ropers (Eds.), *Talent in Context: Historical and Social Perspectives on Giftedness*, Washington, DC: American Psychological Association, 1998. Freeman is disappointed that the perspectives are almost entirely North American and that there are no references later than 1995. She views the book positively, however.

> Simonton's chapter packs a wealth of research, cutting through several myths such as the ideal family .... His chapter structure is based on Shakespeare's observation in *Twelfth Night* that—Some men are born great (biology), some achieve greatness (psychology), and some have greatness thrust upon them (sociology), all of which of course overlap and interact.

She also likes John Feldhusen's chapter that "takes account of societal values and influences." (You do remember, don't you, that Dr. Feldhusen was guest editor of *MRJ #43*, Winter 2000, which included an article by Dr. Freeman?) Freeman closes her review with:

> Most importantly, there is no escape from the total agreement among all of these writers that excellence at all ages involves preparation and the sheer hard work of accumulating knowledge to be used efficiently. Practice, encouragement, and good focused teaching are essential. There is a real need to shift our societal context from the pursuit of happiness toward discipline and hard work. Now, there is a challenge.

I'm reminded of the reply by the great pianist, Paderewski, on being told he was a genius. He said, "Yes, and before that I was a drudge."

- In the November 1998 issue of *Contemporary Psychology* (Vol. 43, No. 11), you'll find a review of MIT professor Steven Pinker's book, *How The Mind Works*, Norton, 1997. After several negative comments, the reviewer said it is nevertheless "invaluable" and "thrusts us into the midst of debates about the role and status of human science itself." In that same issue, you'll find a review of Kincheloe, Steinberg and Gresson (Editors), *Measured Lies: The Bell Curve Examined*, St. Martin's Press, 1996. This is yet another critique of Hernstein and Murray's, the *Bell Curve*, which I've mentioned several times in this column. If you are still engaged in that debate, you may want to look at *Measured Lies*, or at least the review. As for me, I'm outa here!

- Now, Mensans, pay attention! No one is paying as much attention to you as you think. Thomas Gilovich and Kenneth Savistsky, psychologists at Cornell and Williams College, respectively, summarize their research on, "The spotlight effect and the illusion of transparency: Egocentric assessments of how we are seen by others," in the December 1999 issue of *Current Directions in Psychological Science* (Vol. 8, No. 6). "The overriding theme of [their] research is that people's appraisals of how they appear to others tend to be egocentrically biased." In other words, "People tend to believe that the social spotlight shines more on them than it actually does." Okay, maybe their research doesn't apply as much to you and me as to the college students who were the subjects of their research. But consider, "...participants tend to overestimate the salience of their own contributions—both positive and negative—to a group discussion." And, "We have demonstrated that after a failure (whether a social faux pas or an intellectual downfall) individuals expect others to judge them more harshly than they actually do ...and expect observers to rate them more harshly on attributes such as intelligence and creativity than they actually do." Gilavich and Savistsky suspect that may be "due to a failure of judgmental charity on the part of observers—the charity that comes with having experienced similar failures themselves." They label as "the illusion of transparency" our overestimation of the extent to which our internal sensations "leak out," and as the "curse of knowledge" our belief that what we know (about ourselves) is known to others as well. You knew all that, of course, and that "...there is a considerable gap—an egocentric gap—between one's intuitions and the actual judgments of others." Hey! Are you still paying attention to me, or only to your own egocentric perceptions of what I, and Gilovich and Savitsky, are telling you?

- Back in 1993, Joseph S. Renzulli, one of the most prominent and respected advocates of education for the gifted, wrote a paper that's still relevant today. I agree with nearly everything he says, but I must object to a couple of his word choices, as you'll see. He began by saying that programs for the gifted are "in serious jeopardy." In numerous school reforms,

> Ability grouping, advanced classes, and opportunities to pursue advanced content and special interests are viewed as undemocratic .... [W]e seem to have lost sight of an ideal [that] asserts that the uniqueness and individuality of every person should be honored and respected. Translated into educational terms, the ideal requires that learning experiences for all students should be arranged [to be] appropriate to their unique abilities, interests and learning styles. [Otherwise] our educational system will degenerate into a homogeneous, one-size-fits-all curriculum that continues to drive down the overall performance of our entire school population.

The only trouble I have with that, even today, is Renzulli's use of the words every person and all students. I believe that both reason and optimum rhetoric require us to talk about each person and each student. Did you pay attention to the presidential candidates' comments on education and schools? Do you think the politicians will ever stop promising and decreeing programs for all students and begin thinking and talking about each student? No, neither do I.

- A special interest group (SIG) within the American Educational Research Association (AERA) has been formed to provide "a forum for discussing and disseminating research regarding the educational, counseling and scientific implications of [Howard Gardner's] theory of multiple intelligences." Its first newsletter, Spring 2000, cites a Web site that might interest you, whether or not you belong to AERA.

Try www.igs. net/~cmorris and www.angelfire.com/oh/themidasnews/index. To read the first chapter of Gardner's 1999 book, *The Disciplined Mind: What All Students Should Understand*, try www.nytimes.com/books/first/g/gardner-mind. Reviews of it are at www.nytimes.com/books/99/05/09/reviews/990509.09traubt and at www.nybooks.com/nyrev/WWWarchdisplay.cgl?19990506033R.

- Gardner is, of course, an exponent of the idea that any intelligence test that results in merely a single score such as IQ gives an overly generalized picture of each examinee's mental capabilities. I guess he'd call an IQ test a "blunt instrument." Okay, maybe not. Anyway, I like this quotation from his book, *Intelligence Refrained: Multiple Intelligences for the 21st Century,* Basic Books, 1999.

> Unfortunately, throughout human history, the schooling of choice has been uniform, and so it is necessary to understand its power as well as its fundamental flaws. The essence of uniform schooling is the belief that every individual should be treated in the same way. At first, this seems fair; No one has special advantages. And yet a moment's thought reveals an essential inequity in the uniform school. The uniform school is based on the assumption that all individuals are the same and, therefore, that uniform schooling reaches all individuals equally and equitably. But we obviously look different from one another and have different personalities and temperaments. Most important, we also have different kinds of minds ...we each assemble our intelligences in unique configurations.

- Are there dyslexic Mensans? Oh, you bet. That's one of the reasons that Bill Borg (47 Carroll Ave., Norwich CT 06360) started the Learning Disabilities SIG. Brain researchers disagree about what causes reading problems (dyslexia). The three most prominent theories seem to be: (a) that it's a deficit of the brain in dealing with any fast-paced information processing, probably due to abnormal myelin organization; (b) that it's a language-specific problem, probably mostly difficulty with relating spelling with the sounds; and (c) all of the above. A readable discussion of these issues appeared in the APA's *Monitor on Psychology*, March 2000. You might also see, if the title is intelligible to you, Kenneth R. Pugh, et al, "The angular gyrus in developmental dyslexia: task-specific differences in functional connectivity within posterior cortex," *Psychological Science*, January 2000. "The findings support the view that neurobiological anomalies in developmental dyslexia are largely confined to the phonological processing domain."
- For whatever relevance you may find in it, I just learned that it was psychologist Herbert Spencer who coined the phrase "survival of the fittest," four years before Charles Darwin published *The Origin of Species* in 1859.
- Do the fittest smile? Should you have a smile in your survival kit? Well, you already knew that if you smile at people, they tend to smile back. Now researchers at Uppsala University in Sweden, Ulf Dimberg, Monica Thunberg, and Kurt Elmehed, report in the January 2000 *Psychological Science*, carefully controlled studies revealing "that when people are exposed to emotional facial expressions, they spontaneously react with distinct facial electromyographic (EMG) reactions in emotion-related muscles." It happens even when the smiling and frowning expressions in 30-millisecond projected pictures were "backward masked" with neutral expressions so that the subjects had no conscious perception of the smiling or angry expressions. "Our results show that both positive and negative reactions can be unconsciously evoked, and particularly that important aspects of emotional face-to-face communication can occur on an unconscious level."

Let's think about some extended implications. My guess is that, even you faked that first smile, you'd tend to react unconsciously to the other person's resultant, even incipient, smile with a real one. The same would go for a frown, wouldn't it? That's one way we construct the world we live in. Now take a moment to think about that.

- Volumes have been written about the relationship between language and thinking. Alfred Korzibski founded the concept of general semantics on it, the Whorf-Sapir hypothesis asserted that our language habits determine the way we are able to, or even forced to, think about things. I still ponder the question but it seems clear that when we stereotype people with labels, we then behave differently toward and about them. In *Psychological Science*, November 1999, Susan A. Gelman and Gail D. Heyman reported a study, using 150 5- and 7-year-old children, that showed the greater stability of noun labels such as

"Sally is a slob," as compared to "Sally didn't clean up her room today." So how is that relevant here? One implication according to the report is that "...behaviors that would otherwise be considered disruptive are reassessed as creative when a child displaying the behaviors is labeled as "gifted." Did your eyebrows go up when you read that? Mine did.

- An informative Web site I just found is www.brainconnection.com. You can register there to get a periodic newsletter on recent research and there are links to various informative sites on brain neurology, etc. Click on "intelligence," for example.
- Some gifted children who are bored with normal classroom activities respond by acting up. They can get themselves diagnosed as "learning disabled" for having Attention Deficit Hyperactivity Disorder (ADHD). Once they're so labeled, they get extra help, more time to do the SAT, etc., and may even be placed on Ritalin despite some of its awful possible side effects. Says Dr. Claudia Mills, University of Colorado, "We give our children Ritalin in part because we cannot bear that they be below average; and we cannot bear that they not be above average." Dr. Mills is silent, though, about those who cannot bear the idea that any child is way above average.
- Although I'm fairly sure I've said this before, it bears repeating. You can get *The National Research Center on the Gifted and Talented Newsletter* by writing to University of Connecticut, NRC G/T, 2131 Hillside Road, U-7, Storrs, CT 06269-3007. (You needn't mention that you learned about it in the *MRJ*, but then, why not.) It's free. Well, sort of free. Actually, you're already paying for it with your taxes because it's supported by the U.S. Department of Education's Office of Educational Research and Improvement. The Spring 2000 issue (16 pages) had several interesting articles. The one that most caught my attention is by Teri Powell and Del Siegle, "Teacher bias in identifying gifted and talented students." Also, check out the Web site at www.gifted.uconn.edu. I don't know what you'll find there by the time you read this, but on July 3, 2000, I found an article by Joseph S. Renzulli, director of the National Research Center on the Gifted and Talented at University of Connecticut, in which he reviewed 25 years of his research and theorizing. Renzulli begins with a quotation from Jean Piaget. I'm not an avid fan of Piaget, but I like this: "The principal goal of education is to create men and women who are capable of doing new things, not simply repeating what other generations have done."
- The odds are not perfect but somewhat favor intellectually gifted parents having gifted children. Again on the odds, bright parents are more likely to read newspaper articles about such issues as whether there are crucial brain development periods in children. For example, such parents may have read that the first three years of life are crucial for intellectual development and therefore go to considerable pains to provide the infant with intellectual stimulation. The truth seems to be that the press reports on that topic downplayed or ignored the neu-

robiologist's concerns that only underprivileged children may lack such stimulation. Because you are the kind of person who is reading *MRJ*, you probably needn't concern yourself about that. There doesn't seem to be any scientific evidence that additional enrichment beyond a normally healthy environment will offer much advantage for most children. I'm getting this from an article, "A critical issue for the brain," in *Science*, 23 June 2000. There are, it seems, some truly critical learning periods but they come later. "For example, while there seem to be different sensitive areas for different aspects of language learning, 12 to 14 years is roughly the age when the general ease of language learning declines." That's about the time when the density and number of synapses in the language areas of the brain decrease. Keep in mind, though, that these are statistical data and that each individual child is different.

• Mensan Peter Csermely is a professor at Semmelweis University in Budapest, Hungary, who does research in microbiology. Five years ago, he established a nationwide project to provide scientific research opportunities for highly talented high school students, some of whom are Mensans. Five hundred mentors, including 70 members of the Hungarian Academy of Scientists, were found for more than 1,000 students. The project has already extended to Romania, Slovakia and Yugoslavia, and efforts are being made to include Ukraine, Croatia, Slovenia and Serbia. Four annual summer camps have been held for students to discuss their research and to hear lectures by successful scientists. Scientific research clubs have been formed in 78 high schools. If you are interested, his email address is CSERMELY@puskin.sote.hu. When I asked how to pronounce his name, he replied, "CHAIR-may would be quite OK." I also asked whether any of the students were pursuing research in psychology, social psychology, intelligence and giftedness. He said, "Yes, there is an increasing number."

• Hans J. Eysenck, a brilliant but controversial scholar, passed away a year or so ago shortly after publication of his book, *Intelligence: A New Look*, was published in 1998 by Transaction Press. There's a review of it by Nathan Brody in *Contemporary Psychology: APA Review of Books*, Vol. 44, No. 5. Brody's feelings about the book are mixed, as are mine, but he ends by saying, "What is indisputable is that the ideas advanced by Eysenck are at the center of current debates about intelligence."

• Ellen Winner's article, "Giftedness: Current theory and research," in *Current Directions in Psychological Science*, October 2000, ends with several "unanswered questions," such as "whether gifted children differ from average ones only in a quantitative way, or whether they differ qualitatively," "whether the heritabilty of gifts differs across domains" such as art and math, and whether early signs of prodigy predict creative achievement in adulthood. Winner also speculates about whether additional research on savants (persons with extraordinary single talents in math, music, etc., but subnormal IQ), might provide "strong evidence that general intelligence, or what psychologists often call *g*, is unrelated to high levels of achievement in some domains."

- As I write this paragraph on November 20, 2000, I'm still waiting for the final votes to be recounted — or not — in the presidential election. I'm also waiting for replies from my senators and congressman about the status of future funding for education for the gifted and talented so I could give you an update on the August 15, 2000 Congressional Research Service's Report that is reprinted in this issue.
- A reminder: The opinions expressed in this column are mine alone. If you disagree with me, let me know. I might even include your comments in a future "Notes, Quotes and Anecdotes" if you tell me I may. Another reminder: Some items may be more than a year old. There are two reasons for that: (a) I often reread old journals before I discard them, and (b) I write this column bit by bit over several months. Comments and, especially, contributions to "NQ&A" are welcome, believe me. I can't read every relevant periodical, and I estimated recently that I read four and five hours just to glean one paragraph of what you eventually see here.
- Don't put off responding to the reader survey at the end of this issue. We really want your input.

F.C.

The Death of Creativity Measurement Has Been Greatly Exaggerated: Current Issues, Recent Advances, and Future Directions in Creativity Assessment

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Current work on creativity is based on methodologies which either are psychometric in nature or were developed in response to perceived weaknesses of creativity measurement. However, psychometric perspectives on creativity are still a vibrant and vital area of study. Considerable evidence of validity (or lack thereof) has been gathered for a diverse set of instruments and assessment techniques, and the resulting improvement in measurement quality has opened the door to several exciting areas of research. We review some of the current issues, describe recent advances, and suggest future directions for psychometric approaches to creativity research.

Introduction

The study of human creativity is currently receiving a great deal of attention from educators, researchers, and theorists. While much contemporary thought on creativity is moving away from psychometric perspectives toward more postmodern approaches (Feist & Runco, 1993; Runco, Nemiro, & Walberg, 1998), practically all current work on creativity is based upon methodologies which either are psychometric in nature or were developed in response to perceived weaknesses of creativity measurement (Plucker & Renzulli, in press). As such, psychometric studies of creativity conducted in the previous few decades form the foundation of current understandings of creativity. A review of psychometric creativity techniques benefits both individuals attempting to measure creativity and individuals studying creativity via other techniques.

The purpose of this article is to discuss a few of the current concerns about creativity measurement and possible future directions for research and practice in this area. Readers interested in comprehensive descriptions of psychometric approaches to creativity and divergent thinking are directed toward recent reviews of the topic (Davis, 1989; Hocevar & Bachelor, 1989; Plucker & Renzulli, in press; Runco, 1991, in press).

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Current Issues

Fluency as a Contaminating Factor

Divergent thinking (DT) tests are among the most popular techniques for measuring creativity in educational settings (Hunsaker & Callahan, 1995; Runco, 1992a). These tests, also referred to as measures of ideational fluency, generally require students to provide as many responses as possible to prompts such as, "List things that make noise" or "List things that have wheels." Among the most popular DT tests are the Torrance Tests of Creative Thinking (Torrance, 1974) and the Wallach and Kogan (1965) tests. Responses are usually scored for originality (statistical infrequency) and fluency (number of responses).

Several researchers have noted that fluency can be a contaminating influence on originality scores — if fluency is controlled, reliability evidence for originality scores is often very poor (Clark & Mirels, 1970; Hocevar, 1979c; Runco & Albert, 1985; Seddon, 1983). While several suggestions have been made regarding techniques for removing the influence of fluency on originality (e.g., Clark & Mirels, 1970, Hocevar, 1979a, 1979b; Hocevar & Michael, 1979), few studies have evaluated and compared the various suggestions with respect to the reliability and validity evidence for resulting originality scores.

For example, researchers have suggested that DT tests be administered so that every person provides the same number of answers, that originality scores be subjectively determined by external raters, that percentage scoring formulas be used, or that some combination of these techniques be employed (Clark & Mirels, 1970; Hocevar, 1979a; Hocevar & Michael, 1979; Runco & Mraz, 1992). Additionally, the possibility that individuals can subjectively rate the originality of their own responses has yet to be investigated in this context (cf. Runco & Smith, 1992).

Perhaps most importantly, the relative impact of these methods on concurrent validity has not been examined. Hocevar and Michael (1979) correctly observed that a majority of psychometric studies of DT test scores concentrated on obtaining evidence of reliability and convergent validity, while little evidence was gathered of discriminant validity. Consequently, subsequent research attempted to answer the discriminant validity questions but overlooked issues related to convergent validity (i.e., How do the various techniques for controlling for fluency impact correlations between DT originality scores and external criteria of creativity?) and more practical issues (i.e., How do each of the various techniques impact who is admitted to gifted and talented programs?). Although Runco and his colleagues (e.g., Runco, 1985; Runco & Mraz, 1992; Runco, Okuda, & Thurston, 1987) have conducted several studies to investigate the impact of various DT scoring techniques, similar studies explicitly comparing techniques for controlling fluency have yet to be completed. Issues of convergent validity need to be addressed in order for us to gain a comprehensive understanding of the impact of fluency on originality.

Content Generality-Specificity

Creativity has lately been considered to be content specific (Baer, 1993). That is, creative activity within one content area is independent of creativity in other content areas. Both theoretical and empirical evidence have appeared to support the notion that creativity is content specific (Csikszentmihalyi, 1988; Gardener, 1993; Runco, 1989b; Sternberg & Lubart, 1995). Indeed, Baer (1994a, 1994b, 1994c) argues that creativity is also task specific within content areas.

However, the issue of creative content generality-specificity is not without controversy. For example, Plucker (in press-c) questioned the conclusions drawn from content specificity research, suggesting that results appearing to support task specific views of creativity were merely providing evidence of a method effect: Specificity research generally uses alternative assessments of creativity, which is problematic due to the bias of alternative assessments in favor of task specificity.

In a recent debate, arguments were made in support of content specificity (Baer, in press) and content generality (Plucker, in press-a). In general, the participants agreed that the compelling issue is determining the conditions under which creativity is task and content specific and the conditions under which creativity is content general. Taking that logic a step further, researchers should try to identify those aspects of creative production that are task specific and those that are generally applied (i.e., perhaps creative self-efficacy, certain cognitive skills) during each creative moment.

Recent Advances

Predictive Validity

More than any other factor, the perceived lack of predictive validity for DT tests (Baer, 1993; Gardner, 1993; Kogan & Pankove, 1974; Weisberg, 1993) has led researchers and educators to avoid the use of these tests (Plucker & Renzulli, in press). The definitive critique of DT tests' validity was supplied by Wallach (1976), who observed that "subjects vary widely and systematically in their attainments — yet little if any of that systematic variation is captured by individual differences on ideational fluency tests" (p. 60).

Many possible reasons for weak predictive validity coefficients represent weaknesses in methodology more than weaknesses in psychometric approaches to creativity research. For example, studies may be too short in duration, and inadequate statistical procedures may be employed in the presence of nonnormally distributed data (Hocevar & Bachelor, 1989; Plucker & Renzulli, in press; Torrance, 1979). Indeed, researchers who have addressed at least a few of these weaknesses (e.g., Hong, Milgram, & Gorsky, 1995; Milgram & Hong, 1993; Okuda, Runco, & Berger, 1991; Plucker, in press-b; Sawyers & Canestaro, 1989) have collected positive evidence of predictive validity.

Another methodological factor that may have a negative impact on the predictive validity of DT test scores is the reliance on ineffective outcome criteria in longitudinal studies. For example, Runco (1986) stressed that both quantity and quality of creative achievement should be included as outcome variables, in contrast to a traditional reliance on quantity. Again, studies including both types of outcome variables provide considerably improved support for the predictive validity of DT tests (e.g., Plucker, in press-b). Runco (in press) has developed a criterion measure that is directly related to ideation, which is what DT should predict — rather than, for example, achievement in crafts or some verbal domain. Plucker and Runco (in, preparation) are developing a similar ideation checklist. Many of the remaining critics of DT tests' predictive validity are individuals who are primarily critical of psychometric methodologies in general and not specifically of DT tests (e.g., Gardner, 1988, 1993; see Plucker & Renzulli, in press).

Implicit Theories

Perhaps the most exciting development in recent years, both in creativity measurement and the social sciences in general, is related to implicit or folk theories of psychological constructs. In contrast to traditional studies that rely on experts' definitions and theories of creativity (i.e., explicit theories), these researchers assess individuals' personal definitions of creativity (i.e., implicit theories). From a practical standpoint, when people engage in creative activity, they do not have explicit theories in mind. Their thoughts and actions are guided by personal definitions of creativity and beliefs about how to foster and evaluate creativity that may be very different from the theories developed by creativity experts. An understanding of implicit theories provides both researchers and practitioners with insight into creativity.

The study of implicit theories has yielded considerable benefits in three areas related to creativity assessment: straightforward analyses of implicit theories, socially valid techniques for instrument design, and improved strategies for evaluating creative products. In the first area, researchers have found that adjectives such as adventurous, artistic, and curious are generally included in adults' implicit theories of children's creativity (Runco, 1984, 1989b; Runco & Bahleda, 1986; Runco, Johnson, & Bear, 1993); teachers and parents hold similar implicit definitions of creativity, although teachers emphasize social characteristics (e.g., friendly, easy-going) to a greater extent than parents (Runco et al., 1993); and college students' implicit definitions of creativity, intelligence, and wisdom are quite different, with each set of definitions similar — but not identical — to the corresponding set of explicit definitions (Sternberg, 1985, 1990). Cross-cultural and discipline-specific comparisons of implicit creativity theories have yet to be conducted comprehensively and will have important implications for practitioners.

The use of social validation techniques to develop and validate creativity tests and rating scales has also become increasingly common. In these techniques, a target group's implicit theories are used to create creativity rating scales for use with other members of that group. For example, in creating a scale for teachers to use to rate students' creativity, Runco (1984) first conducted a study to identify characteristics that teachers generally included in their implicit theories of children's creativity. The characteristics were used to create the Teachers' Evaluation of Students' Creativity (TESC), which was further modified to increase ease of use and reliability (Runco, 1984). This process produces a socially valid instrument (i.e., one which corresponds well with the implicit theories of the person completing it). Furthermore, the social validation process, which has also been used in the development of parent and student scales, aids in the production of instruments that can be used as criterion in concurrent validity studies of DT tests and other creativity measures (Miller & Sawyers, 1989; Runco, 1984, 1987, 1989b).

A third area in which the impact of implicit creativity theory research can be felt is the evaluation of creative products. While external evaluation of creative products has been popular for many years (Amabile, 1982; Besemer & O'Quin. 1993; Besemer & Treffinger, 1981; Reis & Renzulli, 1991), implicit theory research has led to some recommendations for new procedures.

First, providing explicit guidelines for evaluating the creativity of a product may not be necessary or desirable (Amabile, 1990, 1996; Runco, 1989a). Amabile's (1996) development of and work with the *Consensual Assessment Technique* provides evidence that people can reliably evaluate the creativity of a product with relatively little training when an amorphous definition of creativity is used as the basis for evaluation. This training technique (or lack thereof), capitalizes on the general convergence in people's implicit theories of creativity (i.e., people know creativity when they see it).

Second, Amabile's technique generally calls for the use of expert judges during product assessment (e.g., expert judges of an artistic product should be professional artists). However, recent research has illustrated that intrapersonal and interpersonal evaluative skills are not highly correlated when applied to the evaluation of creative products (Runco & Chand, 1994; Runco, 1992b, Runco & Smith, 1992; Simonton, 1988). Choosing judges is not as easy as it appears at first glance.

Future Directions

While recent developments have been significant, they have illuminated the need for additional theoretical and empirical efforts. Given the current issues and recent developments in creativity assessment, in what directions can and should researchers focus their efforts?

Broadened Application of Psychometric Methods

For the past few decades, psychometric creativity research focused rather narrowly on the analysis of DT test scores and personality checklists. Fortunately, the focus of the field has widened to include other aspects of creativity, including systems of creative activity (Csikszentmihalyi, 1988; Rubenson & Runco, 1992: Sternberg & Lubart, 1995), everyday or "little c" creativity (Richards, 1990), social, affective, and motivational aspects of creativity (Amabile. 1996; Simonton, 1988), and expanded views of cognitive aspects of creativity (Smith, Ward, & Finke, 1995; Ward, Smith, & Vaid, 1997), such as problem finding and evaluation (Runco, 1993, 1994).

The challenge for researchers is to include these new and expanded perspectives of creativity in psychometric investigations of creativity. At the same time, a great deal of information on aspects of DT, especially the interaction of originality, fluency, and flexibility, remains to be uncovered. For example, questions surrounding the impact of technology use (e.g., access to the Internet) on originality and flexibility have yet to be investigated comprehensively. Also, the study of the impact of time on creativity can now be expanded to include variables representing evaluation, problem finding, ideation, and motivation. By expanding conceptions of creativity and assessment, more realistic models and theories can be tested and evaluated.

Reliance on Batteries of Assessments

Research and debate on predictive validity, content specificity-generality, and implicit theories provide concrete reasons for the use of multiple indicators of creativity. This recommendation entails both the use of several measures of creativity and the use of several different types of measures (e.g., DT tests, product assessments, personality measures, activity checklists, teacher, parent, peer, and self ratings).

While implicit theory and social validation research has led to improved teacher, parent, student, peer, and product rating scales, the scales can still be improved to produce more reliable and valid results than those presently attainable. In the same vein, the controversy over content specificity has called attention to the paucity of reliable and valid measures of creativity within specific areas, such as musical creativity (Baltzer, 1988), and predictive validity controversies highlighted the need for the development of more appropriate outcome measures. Implicit in our discussion is the need for additional reliability and validity studies of instruments and techniques for measuring creativity. After all, much of the research cited in this article occurred after or at approximately the same time as published pronouncements of the futility of measuring creativity. Continued validity studies can only have a positive impact on the work of researchers and educators.

Translation into Practice

Creativity researchers face one particular problem that is not always shared with other investigators of psychological phenomenon: The need to translate our work into practice. With the renewed emphasis in creativity as an educational outcome, which can only grow given the popularity of creativity in business circles, nearly all creativity assessment efforts can have an immediate impact on school and classroom practice. Researchers should consider this impact when disseminating results. For example, when evaluating student creative products, researchers are generally cautioned to use different groups of evaluators due to differences in evaluative ability and implicit theories of creativity. However, this recommendation is quite problematic for teachers, who are limited in terms of the time and effort that they can devote to product evaluation. A better solution for teachers may be to develop techniques that allow a student's teacher and peers to help evaluate products in a manner that is less time intensive.

Conclusions

The death of creativity measurement has been greatly exaggerated. Indeed, advances in assessment and statistical methodology have created an environment in which many of the compelling issues regarding creativity can be examined psychometrically. If researchers continue to broaden their conceptions of creativity and assessment, psychometric approaches to creativity will not only rise from their rumored sickbed but will also begin to thrive.

In 1988, Hennessey and Amabile made the following comment about the many roles that creativity assessment is called on to play in psychology and education.

> Clearly, rather than relying on one method to fulfill all these criteria, it is more reasonable to assume that some techniques will be more appropriate to certain assessment needs, such as the identification of unusually gifted children within a large national sample, and different techniques will be better suited to other needs .... (p. 235)

Their thoughts certainly remain applicable, especially given the expanding role of assessment in our schools. But the past decade of creativity research

should also encourage researchers and educators to utilize multiple indicators of creativity for each "assessment need," determining which combination of assessments to employ based on the purpose of the creativity assessment.

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A Statistical Analysis or Special Cases of Creativity

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For some special cases of creativity, we find that its occurrence in each individual's career is random and Poisson-distributed. That is, the rate of production of outputs is constant over each individual's career. The exceptions to this rule are no more than what would be expected by chance fluctuation alone. The distribution of individual productivity across each sample is exponential. That is, most individuals have low productivity and few have high productivity. Similarly, the distribution of career duration is also exponential. We show that these findings are in substantial agreement with the Campbell-Simonton theory of creativity. We also show that these findings are consistent with the statistics of exceedances.

Introduction

Our objective, as stated in the title, is to understand creativity through statistical analysis. Statistical analysis implies that creativity can be measured. Since even the definition of creativity is not universally accepted, its measurement certainly needs substantial development. These issues are too large to be solved for all the forms that creativity might take. So here we take three special cases of creativity in which these issues are somewhat more tractable.

Specifically, our objective is to answer several questions for these special cases. To what degree can creativity be measured? To what degree is creative behavior random versus systematic? How rare is creativity? How long does creativity endure? To what degree do creative people wear out or burn out?

We begin by examining only those creative outputs that have achieved recognition in a nationwide forum. Thus, we explicitly exclude the creativity of children, college sophomores, good soups, and other "small C" achievements (Maslow, 1968, p. 143). Not only are we examining "big C" creativity (Boden, 1991, p. 32; Feldman, Csikszentmihalyi, & Gardner, 1994, pp. 1-2), but creativity at a level that appears in less than 1 percent of the population. Nonetheless, we are not limited to examining those eminent geniuses that make a sample size of one. The samples examined here are typically of several hundred persons.

For our definition of creativity, we use the criteria for a patented invention of new, useful and unobvious. In the context of a patented invention, new means new to the world, not just new to the individual; useful means having economic value (broadly interpreted); and unobvious means the invention method is not

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straightforward. This definition has the support of the five million patents issued by the United States Patent Office and is thoroughly explained in the 3,300 page *Manual of Patent Examining Procedure* (U. S. Patent and Trademark Office, 1996).

Among authors in the field of creativity only a few, de Bono (1992, p. 3), Kim (1989, p. 9) and Torrance (1988), have used the patent office definition of new, useful and unobvious as their definition of creativity. However, there is general agreement among other authors for the requirements of new and useful (or have value). Several authors have chosen a third criterion which is very similar to "unobvious." Amabile (1983, p. 33; 1996, p. 35) chose the criterion of "heuristic," as opposed to algorithmic, to emphasize the uncertainty of the outcome. Similarly, Boden (1991, pp. 30, 41) chose the criterion of "surprising" in the sense that the outcome could not have resulted from generative rules. Feldman, Csikszentmihalyi, and Gardner (1994, pp. 1-2) chose the criterion of "remarkable" in the sense that the outcome transforms and changes the field of endeavor in a significant way. Sternberg (1996, pp. 191-192) chose the criterion of "interesting" in the sense that the outcome possesses connections and syntheses that others don't see. Besemer and Treffinger (1981) chose the criterion "elaboration and synthesis" in the sense of refinement and coherence. Beyond fine shades of meaning, these criteria provide substantial mutual support and tend to join commonly-held creativity criteria to those for patentable inventions.

Even with this definition, the fact remains that creativity is a matter of degree. Nonetheless, for the special cases considered here, there are national forums in which experts agree on which creative products exceed some threshold of achievement, consistent with Amabile's consensual-agreement technique (1982). The nature of the forums is discussed more fully in the next section.

Here, we measure creativity as that number of achievements that exceed the threshold for the field. Thus, we measure the creativity of inventors as the number of patents, the creativity of composers as the number of new works performed, and the creativity of NFL wide receivers as the number of touchdowns. Granted, this measure does not measure the quality of creativity, it only measures the quantity above a minimum threshold of quality. But, using Simonton's Equal-Odds rule (1997), this quantity is a statistical estimate of quality.

Using this measure of creativity, it is straightforward to examine databases of individual achievement and answer the questions regarding randomness, rarity, endurance and exhaustion. We begin with a description of the samples chosen for statistical analysis. Then we show the yearly production is random and follows the Poisson distribution. Then we examine the rate of production and its duration and show these forms have a theoretical basis. We also show that these samples are consistent with the Campbell-Simonton theory of creativity.

Choosing the Samples

The samples of creative achievement were chosen to satisfy a variety of considerations. Obviously, they need to represent creative achievement that is commonly recognized in society.

In addition, a database of individual achievements needs to be available. Finally, these samples represent creative achievements in art, technology and sport, a wide range of fields.

Certainly most persons would agree that composing a symphony, opera, or concerto that is performed by a professional orchestra is a creative achievement. Here the threshold of achievement is more than just the composer's opinion. The selection committee for the orchestra must agree that the not-previously-performed work is significant enough to exclude a known work from the program. Generally, these selection committees are made up of the orchestra conductor, the musical director, and other persons knowledgeable in the field. This is a good example of Amabile's (1982) consensual-assessment technique. Fortunately, a good database exists (Slonimsky, 1994). This selection process is also consistent with the criteria of new, useful, and unobvious. Newness is self-evident; otherwise the work would be known. By useful is meant that it is consistent with musical standards. Unobviousness is similar to the assessment of musical originality. We recorded the dates of the first performance of individual composers' symphonies, operas, and concertos for the period 1932 through 1976. A total of 1,238 composers are in this sample.

Invention has been widely accepted as creative behavior. Here the threshold of achievement is being granted a patent by the U. S. Patent Office. As described above, these criteria have stood the test of many scores of years, millions of patents, dozens of court cases, and are described in a voluminous handbook. We recorded the dates that patents issued for a random sample of inventors (Huber, 1998b, 1998c) for the period 1976 through 1997 from the Internet Web site www.uspto.gov. Only those patents issued since 1976 are electronically accessible. A total of 715 inventors are in this sample.

Perhaps a more controversial sample is that of National Football League wide receivers' touchdowns. However, established authors on creativity such as Perkins (1981, pp. 273-274) and Abra (1997, pp. 38-50) find a strong relationship between creativity and athletics. We submit here that NFL wide receivers exhibit a higher degree of creativity than ordinary professional athletes. Let us consider a wide receiver's touchdown performance in the context of the criteria of new, useful, and unobvious. Usefulness is self-evident; touchdowns make for winning scores. Catching a touchdown pass is not merely a matter of running faster. The extensive use of films record each wide receiver's techniques. So, a successful wide receiver must deceive the defenders. If the techniques are not consistently new and unobvious, they will be anticipated by the defender and the touchdown will not be made. We recorded the touchdown records of NFL wide receivers for the period 1972 through 1996 (Neft, Cohen, & Korch, 1997). A total of 539 wide receivers are in this sample.

Testing for Randomness

In common statistical methods, an implicit assumption is that the underlying process does not change during the time interval of the study. The descriptive statistical terms are time-invariant, stationary, homogeneous, random processes. A standard way of making this test is the method of runs (Gibbons, 1986; Johnson, Kotz, and Kemp 1993, pp. 422-425). This is a test of dichotomous (i.e. two-valued) data. For numeric data that is not naturally two-valued, it can readily be so classified as above or below the sample mean.

For the runs test of randomness, we chose those individuals with at least four outputs occurring over at least nine years.These criteria ensure that the extreme tails of the theoretical distribution are sufficiently populated for a useful empirical test. We calculated the probability of the observed runs for each individual and the percentage of individuals with runs probabilities between .l and .9 of the cumulative distribution. This is a two-tailed test of a proportion when the population value is known to be 80 percent (Snedecor 1989, p. 121). The results are shown in Table 1. For composers and inventors, the random hypothesis cannot be rejected at .05 significance.

Unfortunately, the detailed time pattern of outputs for all NFL wide receivers is not recorded. However, for Hall of Fame receivers, a minority of individuals exhibited a surge in outputs during their career. Examination of eminent inventors (described in the following section) finds a similar pattern, even though the sample of less-than-eminent inventors exhibits random outputs. Therefore, we assume that the same relationship holds for NFL wide receivers and so the complete sample is predominantly random. The results are shown in Table 1. The overall conclusion is that composers, inventors, and NFL receivers exhibit a random pattern of outputs.

Table 1

Test Results for Randomness and fit to Poisson Distribution

Sample	**Size**	**% with .1<p(runs)<.9**	**% with .1<p(Poisson)<.9**
Composers	253	85	85
Inventors	61	89	72
NFL Hall of Fame receivers	21	62	38
Eminent Inventors	81	72	51

Testing Fit to the Poisson Distribution

Having established that the processes that generate creative outputs for these samples are random, we can progress to examining the distribution of outputs for each individual. The yearly outputs of composers, inventors and NFL wide receivers are discrete events. For discrete events, it is commonly observed that the yearly pattern of outputs follows the Poisson distribution. We calculated the Poisson dispersion statistic (Boswell, 1986; Johnson, Kotz, & Kemp, 1993, p. 172) for each individual and calculated the percentage of individuals with values between .1 and .9 of the cumulative distribution. This is a two-tailed test when the proportion is known to be 80 percent (Snedecor 1989, p. 121). As shown in Table 1, the Poisson hypothesis for composers and inventors cannot be rejected at .05 significance. However, some of the Hall of Fame NFL receivers exhibited a surge pattern. Examination of eminent inventors finds a similar pattern. Therefore, we assume that the same relationship holds for ordinary NFL wide receivers and so the complete sample is predominantly Poisson distributed.

The Poisson distribution resembles the normal distribution, but skewed toward lower values. In an overly simplistic way, the Poisson distribution may be viewed as a normal distribution with the negative tail "folded" into the adjacent positive values. As we shall discuss in a following section, these findings of randomness and Poisson distribution do not mean that there is no opportunity for individual effort in these fields. Indeed there is abundant anecdotal evidence that individual effort is important. These findings are also consistent with the anecdotal reports of the difficulty of being creative on demand. The long term average for an individual is constant, but the short term fluctuations are substantial. In the next section, we will find that the differences between individuals are substantial.

Finding that composers, inventors, and NFL wide receivers follow the Poisson distribution is important because it simplifies the subsequent analysis. The Poisson distribution has several unique characteristics. First, it is described by one parameter, which is equal to both the mean and variance of yearly outputs (Johnson, Kotz, Kemp, 1993, p. 151; Snedecor & Cochran, 1989, p. 132). Second, the Poisson distribution of yearly outputs arises from an exponential distribution of times between outputs (Johnson, Kotz, Kemp, 1993, p. 153; Johnson, Kotz, & Balakrishnan, 1994, p. 508; Engelhardt, 1995, p. 75), which provides a more precise estimate of the Poisson parameter for small samples. In the next section, we examine how this Poisson parameter for individuals varies across the samples.

Estimating Frequency of Outputs

In order to avoid confusion among the rate of production in the different fields (e.g. patents/yr, newly-performed works/yr., touchdowns/yr.), we use the term Frequency to describe how frequently each individual exhibits creative achievements. Thus, Frequency is the value of the Poisson parameter that describes each individual's rate of production.

The cumulative distributions of Frequency for the samples are shown in Figure 1. They exhibit the straight-line form consistent with an exponential distribution of Frequency across each sample. The exponential distribution is quite unlike the common normal distribution. The exponential distribution has its peak at zero Frequency and falls smoothly as Frequency increases. A crude, qualitative analogy is that the exponential distribution resembles the upper tail of the normal distribution. The exponential distribution is described by a single parameter equal to the average Frequency, which we denote as phi. The common method of determining whether a given model is appropriate for a sample is the QQ plot (D'Agostino, 1986). Assuming an exponential model for the distribution of Frequency, the QQ plots for composers, inventors, and NFL receivers are shown in Figure 2. If the exponential model is valid, the plot will exhibit a substantial linear region. Each of the

Figure 1

Cumulative Distribution of Frequency, individuals with at least four outputs

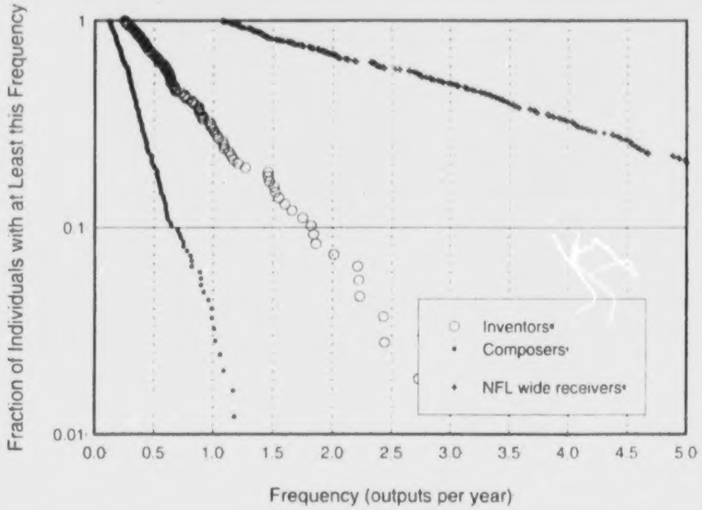
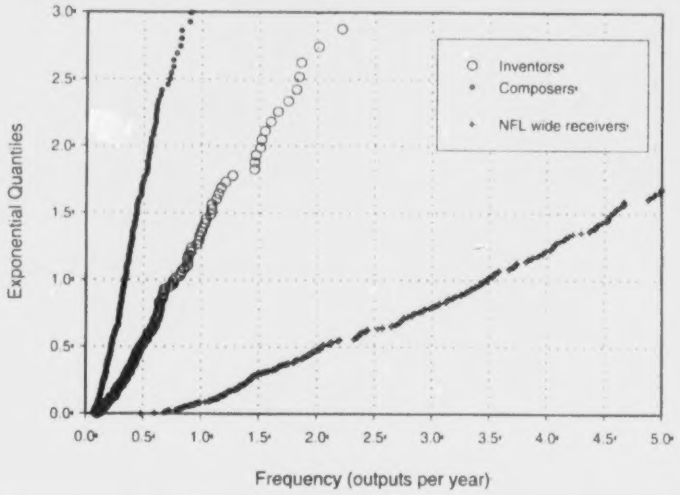


Figure 2

QQ Plots for Frequency, individuals with at least four outputs



samples has a linear region above a small threshold and below a large threshold.

The small threshold arises from two factors. The first factor is the minimum value of four outputs recorded within the interval (e.g. 1976-1997). It is likely that there are individuals with Frequency so small that their four outputs are not recorded within the finite interval. The second factor is the fundamental property of the statistics of exceedances which is defined above a threshold, as discussed in a later section. The large threshold generally occurs below .10 cumulative probability and is subject to chance fluctuations for the small number of individuals occurring there. The parameter of the exponential distribution was estimated by regression on the linear region (inventors: 0.25-1.25; composers: 0.13-0.65; NFL wide receivers: 1.0-4.6; which is a ratio greater than 4.5:1 in all cases). The Cramer-von Mises goodness-of-fit for all individuals above the lower threshold was calculated from the appropriate tables (Stephens, 1986). The results are shown in Table 2. The goodness-of-fit to the exponential distribution is excellent, always greater than .50. So, even the deviation for high productivity individuals is not sufficient to reject the exponential model. The value of the samples' parameter phi is plausible. It implies that it takes an average of four years to compose a symphony, opera, or concerto. Yet, touchdowns need to be more frequent to keep spectators interested.

Table 2

Exponential Distribution of Frequency

Sample	Size	phi	Significance
Composers	247	.25	.50
Inventors	108	.60	.95
NFL wide receivers	533	2.53	.75
Eminent Inventors	105	1.23	.90

It would seem to be a remarkable finding that the distribution of creative productivity should be qualitatively the same across such diverse fields. It also is remarkable to find such excellent goodness-of-fit to human performance. In a later section we will present a theoretical basis for these findings. An obvious inquiry is whether these findings also apply to eminent creative achievement. Put another way, an objection to these findings is that these databases include the journeyman along with the eminent. This larger proportion of lesser creative individuals may mask the performance of the eminent. We performed the same analyses on those inventors who are recipients of the National Medal of Technology (http:// www.ta.doc.gov), Inventors Hall of Fame (http:// www.invent.org), Lemelson-MIT Prize (http://www.mit.edu), Industrial Research Institute Achievement Award (http:// www.iriinc.com), and Intellectual Property Owners Award (http://www.ipo.org). The table shows the same qualitative results as the other samples. Furthermore, it is reasonable that eminent inventors produce at a greater rate (larger phi) than average inventors.

Now that we have determined the distribution of Frequency and its average (phi), a natural next step is to examine how long these creative individuals continue their careers. This topic is discussed in the next section.

Estimating Lifetime

The career duration of creative persons has long been of great interest. There are abundant anecdotal reports of exhaustion and burn-out (Abra, 1989). Here we use statistical methods to measure career duration.

In order to estimate the distribution of career duration, we need to account for the samples being mixtures of completed careers and incomplete careers. By incomplete careers, we mean the individual began or ended his or her career outside the time interval of study. This is a common issue in survivor analysis, as used in medical treatments (Klein & Moeschberger, 1997, pp. 55-82) and device reliability (Elsayed, 1996, pp. 263279). Consistent with these fields, we will refer to career duration as Lifetime, recognizing that it is not the same as biological lifetime. Similar to the analysis of randomness and Frequency, we examined the Lifetimes of individuals with at least four outputs.

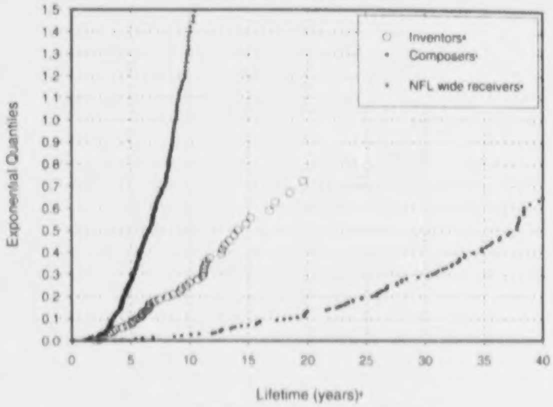
The first step is to determine which Lifetimes are complete; the statistical term is uncensored. For NFL wide receivers, complete careers are recorded (Neft et al., 1997) and no estimation is needed. For composers, the interval of 1932-1976 was chosen such that if of the remainder of the record 1900-1931 and 1977-1991 (Slonimsky, 1994) disclosed no new works, the composer's Lifetime was deemed complete (uncensored). For inventors, the situation is more complicated. The short period of observations (1976-1997) forces us to estimate each inventor's career start and end dates. To do this, we make use of the exponential distribution of times-between-outputs.

As in most statistical analysis, we are forced to make a compromise. If we chose that completed Lifetimes are those where the estimated start and end dates lie within the interval endpoints, there is up to .37 probability (exp(-1)) that an unrecorded event lies outside the interval. Thus, too many Lifetimes will be incorrectly deemed complete (uncensored). The compromise we chose was that a Lifetime was deemed complete (uncensored) if the first recorded output was at least 1.61x(mean-time-between-outputs) from the interval beginning and the last recorded output was at least 1.61x(mean-timebetween-outputs)/2 from the interval end. This choice typically corresponds to a .04 probability (exp(-1.61)*exp(-1.61)) of error if both the first and last outputs are exactly at the interval boundaries. For other individuals, the probability is less.

Working with samples that have censored events is much more complicated than that for complete samples. We chose the common method of the Kaplan-Meier Product Limit Estimator (KMPLE) (Kaplan, & Meier, 1958, Michael, & Schucany, 1986; Klein et. al., 1997, p. 84) to represent the cumulative distribution of Lifetime.

Figure 3

QQ Plots for Lifetime, individuals with at least four outputs



Similar to the analysis of Frequency above, we assumed an exponential model for the distribution of Lifetime. The QQ plots for composers, inventors, and NFL receivers are shown in Figure 3. If the exponential model is valid, the plot will exhibit a substantial linear region. Each of the samples has a linear region above a small threshold and below a large threshold.

The small threshold arises from two factors. The first factor is the minimum value of four outputs recorded within the interval. Some of the individuals below the linear region would have more than four outputs if the interval were longer. The second factor is the fundamental property of the statistics of exceedances which is defined above a threshold, as discussed in a later section. The large threshold may arise from long Lifetime individuals ceasing work for reasons different from that for shorter Lifetimes, as discussed in a later section.

The parameter of the exponential distribution was estimated by regression on the linear region (inventors: 4.5-20.0; composers: 10-26; NFL receivers: 4-8). The goodness-of-fit for all individuals above the lower threshold was calculated using Koziol's (1980) method and the appropriate tables (Stephens, 1986). As discussed by Stephens, this estimate is crude, though the best available. The results are shown in Table 3.

Table 3

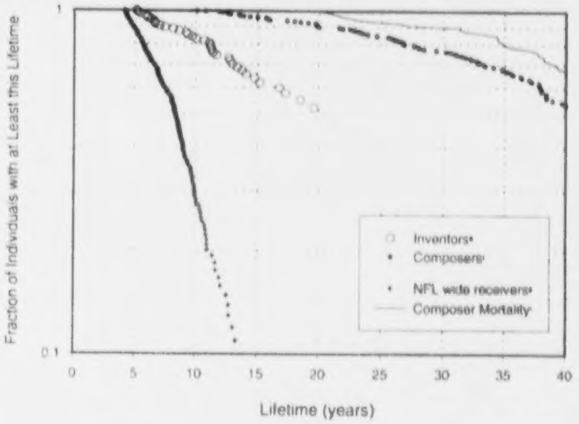
Exponential Distribution of Lifetime

Sample	Size	tau	Significance
Composers	261	84.9	.01
Inventors	108	22.3	>.50
NFL wide receivers	392	5.7	.10
Eminent Inventors	112	39.7	>.50

The cumulative distributions for Lifetime for the samples are shown in Figure 4. They exhibit the straight line form consistent with an exponential distribution of Lifetime across each sample. The exponential distribution is described by a single parameter equal to the average Lifetime, which we denote as tau. Goodness-of-Fit results are shown in Table 3. The values of each sam-

Figure 4

Cumulative Distribution of Lifetime, individuals with at least four outputs



ple's parameter tau is plausible. Composers' careers are far longer than NFL wide receivers. The fit for inventors is excellent, being greater than .5, the maximum value in the table. The fit for composers and NFL wide receivers is poor, but entirely due to the down-break near half the maximum Lifetime. Fit for Lifetimes less than the down-break is .50 for NFL wide receivers and .25 for composers.

As an added confirmation of this methodology, making use of birth and death dates of these composers (Slonimsky, 1984), produces the biological mortality plot shown in Figure 4. It lies near to, but slightly above the Lifetime survivor plot. This shows that the average Lifetime of composers' works estimated by this method is not larger than biological lifetime, even though posthumous performances occur for some composers. It also shows that death is a major factor in the decline of Lifetime as measured by new works.

It would seem to be a remarkable finding that the distribution of career duration (at least in the early years) should be qualitatively the same across such diverse fields. It also is remarkable to find such excellent goodness-of-fit to human performance. In a later section we will show a theoretical basis for these findings.

An obvious inquiry is whether these findings also apply to eminent creative achievement, as discussed above for Frequency. We performed the same analyses on the eminent inventor sample. Table 3 shows the same qualitative results as the other samples. Furthermore, it is reasonable that eminent inventors produce for a longer time than average inventors. Roe (1951, 1952, 1953) found that achievement, persistence, and motivation go hand-in-hand.

There are plausible reasons for the down-break observed for composers and NFL wide receivers. For composers, the departure from linearity corresponds to 60 years of age, where retirement, death, and disability become significant contributors to attrition. Similarly for NFL receivers, long Lifetime individuals are usually in the starting lineup, suffer more than 100 collisions each year, and are more at risk for catastrophic injury. The distribution for inventors does not exhibit a down-break, perhaps because the interval of 22 years is shorter than the retirement-limited career of about 40 years. The linear regions in these samples also indicates a constant hazard rate (Shapiro, 1995; Klein &

Moeschberger, 1997, p.27). That is, there is no substantial evidence for exhaustion of creative potential in these intervals.

As mentioned in the previous sections, this statistical analysis does not mean that creativity is entirely random. Individual effort does have an effect, as discussed in the next section.

Randomness and Individual Effort

For those who labor long and hard on creative work, the notion of random variables may be offensive. Perhaps a useful way to address the issue of randomness and individual effort is to examine the folk-saying, "Nothing is certain but death and taxes." Indeed, these events may be certain to occur eventually, but the time of death and the amount of taxes is anything but certain. In fact, both death and taxes are commonly treated as random variables.

To each of us, our death is an intensely individual event. Most of us intend to enjoy a long life as a result of our individual efforts - better medical care, exercise, proper diet, etc. For some of us, these efforts will result in a longer life than average. But for others, their lifetime will be less than average. Biological lifetime has been a matter of statistical analysis for centuries, and the life insurance industry is fundamentally based on the fact that lifetime is a random variable. Thus, death is unique to each individual, but a random variable across a large sample.

The issue is similar for taxes. Each person's taxes may be computed accurately (disregarding interpretations of some portions of the tax laws). To each of us, our tax payment is an intensely individual event. However, some person's taxes will be above average and some below. Some may increase and some may decrease. But governments plan their tax revenue by treating each individual's taxes as a random variable.

So, the previous statistical analysis does not mean that creative achievements "just happen out of the blue." It may appear that way from time to time. But some individuals have many more of them than others. And some individuals enjoy a much longer career than others. The hypothesis of uniform distribution for these variables is rejected for each of these samples at significance $<.001$.

The finding that yearly production is constant also needs explanation. These samples represent individuals who are at the highest levels in their fields. Such individuals are extremely gifted, tend to learn the teachable skills quickly, and thereafter are substantially self-taught. Thus, the overall rate of increase or decrease is smaller than these statistical methods can detect.

Then what explanation is there for these excellent fits to standard statistical distributions? One plausible answer arises from extreme value theory and the statistics of exceedances, as is discussed in the next section.

The Statistics of Exceedances

We postulate that each person's career output can be characterized by two random variables, loosely termed talent and tenacity. The first variable, talent, refers to any skills, intelligences, knowledges, and plain hard work that are important for success in a field. There have been such abundant lists of these factors that only a few can be referenced here (Mttron Hirsch, 1931, p. 235-236; Rossman, 1931, pp. 39-40; MacKinnon, 1962; Levitt, 1963, p. 73; Taylor D Barron, 1963, pp. 385-396; Mackworth, 1965; Telford & Sawrey, 1967, pp.191-192; Wallas, 1976, pp. 69-73; Austin, 1978, p. 112; Barron Harrington, 1981; Simonton, 1988, p. 64; Drucker, 1993, p. 49; Gardner, 1993, pp. 316-320; Feldman et al., 1994, pp. 22-23; Florman, 1994, p. 183; Loehle, 1994; Sternberg & Lubart, 1995, pp. 283-288; Amabile,1996, p. 98; Sternberg, 1996, pp.191-192; Reiter Palmon, Mumford, Boes & Runco, 1997). We will also assume that the method of combining these talents (e.g. additive, multiplicative, etc.) that determines success in a field produces a continuous distribution. Whatever the shape of this distribution, its upper tail represents the talents of individuals who have the propensity for frequent outputs in the field. Thus, the variable talent generally will be observed as Frequency (outputs per year). Put another way, talent does not assume eminence, just sufficient success to have at least one career output. Put more specifically, the model being developed here describes the major-achievement or "big C" creativity, as distinguished from commonplace problem-solving, as discussed in Boden (1991, p. 32), Feldman et al. (1994, pp. 1-2) and Maslow (1968, p. 143), but not limited to genius-level achievement.

The other variable of interest is tenacity. Numerous researchers have listed the following near-synonyms as important for a productive life: perseverance (Rossman, 1931, pp. 39-40), persistence (Torrance, 1976, p. 66; Austin, 1978, p. 112; Mansfield & Busse, 1981, p. 97; Amabile & Grykiewicz, 1988, p. 6, Eisenberger, 1992; Abra, 1997, p. 44), endurance (Rushton, Murray & Paunnonen, 1987), commitment (May, 1975, p. 20), sustained devotion to work (Roe, 1951, 1952, 1953), and sustained effort (Garfield, 1986, p. 78). However, we take a more restrictive definition here. It might be useful to describe what tenacity is not, in this context. Tenacity is not the ability to produce the next output, which embodies the ability to continue problem-finding (Mackworth, 1965; Getzels & Csikszentmihalyi, 1975, pp. 90-116), effective problem-definition (Conger, 1995, p. 178), problem-solving, etc., and is included in talent. Tenacity is the opposite of quitting - of ceasing production altogether. For this model, tenacity is field dependent; outputs in one field (e.g. patents) do not include outputs in a dissimilar field (e.g. manufacturing processes). That is, tenacity is affected by the option of an alternative career. In this author's 30 years experience in new product development, observing over 200 inventors, a substantial number of them ceased inventive work to take roles in technical management, manufacturing, and marketing. For example, Art Fry, the inventor of the ubiquitous Post-It Note, concentrated the rest of his career on developing the many new manufacturing processes needed to make the invention a practical reality (Fry, 1995). Similar to the assumptions for talent above, we assume that these tenacity factors combine into a continuous distribution. Whatever the shape of this distribution, its upper tail represents the tenacity of people who have the propensity for an enduring career in the field, as opposed to an isolated, spurious episode. Thus, the variable tenacity will generally be observed as Lifetime (years of effort).

The upper tails of well-behaved continuous distributions are described by the statistics of exceedances (Pickands, 1975; Perline, 1982; Smith, 1984; Davison, 1984; Embrechts, Kluppelberg, & Mikosch, 1997). The statistics of exceedances is a special case of Extreme Value Statistics (Gumbel, 1960; Castillo, 1988; Johnson, Kotz, & Balakrishnan, 1995, pp.1-112). Whereas Extreme Value Statistics is ordinarily concerned with the maximum value observed, the statistics of exceedances is concerned with all the values larger than some high threshold. In the context of this study, Extreme Value Statistics models the best invention of the year, while the statistics of exceedances models inventions that exceed some standard criteria (i.e. patent criteria of new, useful and unobvious). While the statistics of exceedances is most commonly used in weather analysis, there is no fundamental reason why it cannot be applied to human behavior. In this context, the statistics of exceedances is used to describe behavior that exceeds some high threshold and, therefore, is rarely observed. In common terms, these would be extraordinary achievements.

Surprisingly, the distribution of exceedances for all common continuous "textbook" distributions is the Generalized Pareto Distribution (Pickands, 1975; Johnson, Kotz, & Balakrishnan, 1994, pp. 614-620) of which an important special case is the exponential distribution. Thus, it is plausible, though not directly provable, that the exponential distributions for Frequency and Lifetime found for these samples arise from the statistics of exceedances. This would explain the excellent goodness-of-fit. That is, in a large sample, there will be individuals with a wide variety of combinations of talents; these will be manifest in a continuous distribution of creative potential and the upper tail will tend to exhibit a good fit to the exponential distribution. Similar reasoning applies for Lifetime.

We have shown that this statistical analysis has some support in statistical theory. In the next section, we will examine these results in the context of the Campbell-Simonton theory of creativity.

Comparison to the Campbell-Simonton Theory

Summarized very briefly, the Campbell-Simonton theory of creativity (Simonton, 1997, 1988) makes several testable statements about creative outputs. In the following list, we show how the results of this study compare to the theory.

1. For these samples, outputs are stochastic, which is consistent with a blind variation and selective retention process.
2. For these samples, individual differences are significant and stable, which is consistent with differences in chance permutations of mental elements, stable configurations, and social acceptance.
3. For these samples, the distribution of productivity (Frequency) is skewed right as predicted by the Campbell-Simonton theory, though with a specific distribution form and with remarkable adherence to the exponential distribution.
4. The fact that the runs test indicates a constant yearly output is not necessarily inconsistent with the ideation-elaboration model for age and achievement. That model explains only a fraction of the total variance and only for long Lifetime individuals (Simonton, 1977). The methods used here would not detect such a small effect.
5. Average Frequency (phi) for eminent inventors is larger than for the random sample. This is some support for Simonton's Equal-Odds rule that quantity is a measure of quality (1997).
6. For inventors and composers, there is no evidence for exhaustion, at least for ages younger than those when death, disability, and retirement are substantial. For these samples, this would indicate that exhaustion of creative potential is small. For NFL receivers, there is an increase in hazard rate, but the data is inadequate to separate physical injury from creative exhaustion.
7. Does this statistical analysis help resolve different views on the "blind variation and selective retention" aspect of the Campbell-Simonton theory (Sternberg, 1998; Perkins, 1998)? Sternberg and Perkins argue for a more sighted or systematic variation and selection. What these samples demonstrate is that whatever sighted or systematic variation and selection exists, it does not significantly contribute to a pattern of outputs that is more consistent than would be expected from chance fluctuation alone. But it may contribute to the greater tendency of surges among eminently creative persons. However, the Campbell-Simonton theory also includes different efficiencies of heuristics for selecting combinations of mental elements. So this analysis does not resolve these different views. It would be helpful if the competing models were further developed to emphasize distinguishing characteristics such that an objective, experimental analysis could examine these differences.

Conclusions

For the cases of composers, inventors, and NFL wide receivers, the results of this statistical analysis are remarkably consistent, especially considering the diverse fields of art, technology, and sport. We now return to the questions posed in the introduction.

To what degree can creativity be measured? For creative outputs that are substantial enough to be recognized in a nationwide forum, eminent individuals exhibit a greater rate of outputs than others and this rate is an indirect measure of individual creativity.

To what degree is creative behavior random versus systematic? The production of outputs deviates from randomness no more than would be expected from chance fluctuation alone. An exception is eminent individuals, some of whom tend to exhibit surges, though the majority of eminent individuals exhibit random outputs.

How rare is creativity? At least for a nationwide acceptance criterion for creativity, the occurrence is extremely rare. Taking inventors as an example, Huber (1998a) reports that only 1.4 percent of adults have at least one patented invention. The inventors with at least four patents are 17 percent of the those with at least one patent. This reduces the estimate of those individuals with a measurable occurrence of creativity to 0.24 percent (0.0140.17x100). Thus, samples of the general population of 400 or less are unlikely to include even one person who has the potential for this level of achievement.

How long does creativity endure? This is domain-dependent, with composer's careers dominated by biological lifetime and athletes having much shorter careers. However, in each field, many individual's careers ended before any maximum limitation. Thus, researchers should not assume that all individuals are active throughout a given time interval.

To what degree do creative people wear out or burn out? In these samples, both the test of randomness and the constant hazard rate observed in the distribution of Lifetime indicate that creative people do not decrease (or increase) their rate of production. This finding is not necessarily inconsistent with age-and-achievement findings, which are generally small effects observed in large samples of long-career individuals.

Well, what does all this mean? We now depart from rigorous statistical methodology and embark upon some potential implications of this study.

Taken together, the broad findings that individuals exhibit random outputs over time and follow the Poisson distribution tend to imply that environmental effects are small. That is, if an individual were able to devise a successful strategy for finding or solving creative problems, one would expect to observe a substantial increase (either temporary or permanent) in yearly outputs. Such increases are only observed for a minority of eminent inventors and NFL receivers. These implications provide substantial support to the common observation that creative people are intrinsically motivated (Amabile, 1983) and that it is difficult to be creative on demand.

Furthermore, the broad findings of exponential distribution for Frequency and Lifetime across individuals also tends to imply that environmental effects are small within fields. That is, if some firms had especially effective policies and procedures for managing inventors, one would expect to observe bumps and dips in the distribution of Frequency and Lifetime.

In addition, the rarity of these individuals and the relatively long periods between outputs tend to suggest that small sample and short-term research studies will not produce predictive results. Moreover, since individuals' rates of production and career durations vary by more than a factor of 10, one would expect that any indicative personality factors or attitudes will also vary among them. Thus, studies that do not explicitly account for these variations may not detect important variables.

These findings also provide some explanation for the lack of success in teaching creativity. The great rarity of high productivity individuals means that any group from the general population (e.g. college sophomores) will have a majority of persons with very little inventive talent (at least as measured here as Frequency). Thus, most of the class "won't get it" and any post-instruction measure of real-world creativity will find little improvement. Nonetheless, the mechanics of creativity might be taught, such as the need for problem finding, stages in the creative process, impediments that can be expected, etc. Those individuals with nascent talent might become enlightened by this knowledge and then nominate themselves for a mentoring relationship with a master in their field.

A subject of further research is to examine these findings for inventors across firms that are perceived to have diverse innovative cultures. Another future research project is to examine factors that predict rates of output and career duration for individuals.

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States of Excellence

David Lubinski and Camilla Persson Benbow, Vanderbilt University

Research from the individual-differences tradition pertinent to the optimal development of exceptional talent is reviewed, using the theory of work adjustment (TWA) to organize findings. The authors show how TWA concepts and psychometric methods, when used together, can facilitate positive development among talented youth by aligning learning opportunities with salient aspects of each student's individuality. Longitudinal research and more general theoretical models of (adult) academic and intellectual development support this approach. This analysis also uncovers common threads running through several positive psychological concepts (e.g., effectance motivation, flow, and peak experiences). The authors conclude by underscoring some important ideals from counseling psychology for fostering intellectual development and psychological well-being. These include conducting a multifaceted assessment, focusing on strength, helping people make choices, and providing a developmental context for bridging educational and industrial psychology to facilitate positive psychological growth throughout the life span.

Since the beginning of recorded history, the extraordinary gifts that some individuals possess and the ways these gifts are nurtured have fascinated people. This may be particularly true for those intellectual attributes that manifest precocity in rate of development and terminal level of performance. How does such precocity emerge? Are there ways to cultivate its manifestation? Are there barriers in place that attenuate its development into exceptional adult attainment? These are among the most critical questions being addressed by investigators interested in talent development.

Although there are many ways to approach these issues from various disciplinary perspectives, in this article we show how traditional individual-differences measures, used within the theory of work adjustment (TWA; Dawis & Lofquist, 1984) framework, can facilitate optimal development of talent. We also synthesize basic but widely scattered findings in the psychological literature to reveal the many converging lines of evidence that support this practice. Detailing exact interventions or procedures for adjusting educational curricula (Benbow & Lubinski, 1996; Benbow & Stanley, 1996; Lubinski & Benbow, 1995; Winner, 1996) is, however, beyond our scope here. Rather, we limit ourselves to demonstrating how findings in positive psychology provide foundational support for tailoring a school's curriculum to match individual differences among talented students. We begin with a review of early approaches to talent

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development within the individual-differences tradition; this sets the stage for using ability and preference assessments to design optimal learning environments for intellectually talented youth.

Early Work

Around the time the science of applied psychology began, scholars were intrigued by the possibility that in-depth studies of exceptionally able students might help answer the questions posed above Even staunch empirical outlets like the *Journal of Applied Psychology* devoted space to some case history reports (e.g., Coy, 1918; Garrison, Burke, & Hollingworth, 1917,1922; Hollingworth, 1927). These students were seen as so fascinating and their intellectual development as so remarkable (and of eventual value to society) that they were worth idiographic (N = 1) profiling. What these case histories revealed, among other things, was that the terms intellectually gifted or highly talented are imprecise. The breadth of diversity found within this special population was profound across both intellectual and nonintellectual attributes. The students were anything but a categorical type. Hence, no single environmental manipulation would address the needs of all talented youth. There was no "silver bullet."

Upon reflection, this finding was unsurprising. One third of the total range on any given normally distributed dimension is found within the top 1 percent (a common arbitrary criterion for classifying an individual as "gifted"). Scores marking the top one percent on general intelligence, as measured by conventional psychometric (IQ) assessments, begin at an IQ of approximately 137. Yet, IQs can extend beyond 200. Individual differences within the upper segment of this over 70 point IQ range lead to huge differences in the educational environments required for ensuring optimal development.

Although Leta Hollingworth's (1942) volume *Children Above 180 IQ* helped solidify this conclusion, there were other voices. Many early pioneers of applied psychology stressed the heterogeneity in gifted populations; they pointed out the concomitant necessity of and benefits for structuring these students' educational curriculums at a level and pace commensurate with their rate of learning. Thus, by the 1950s, when the Bingham Lecture Series entitled "The Discovery and

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Development of Exceptional Abilities and Capacities" began (all of the lectures in this series were published in the *American Psychologist*), almost every contribution to the series underscored the empirical evidence for this perspective (e.g., Ghiselli, 1963; Paterson, 1957; Stalnaker, 1962; Terman, 1954; Wolfle, 1960). Moreover, most contributors promoted "educational acceleration" to respond to the unique educational needs of these gifted children. It is important to point out before leaving this topic, however, that educational acceleration is a misnomer, as students are not hurried along but rather placed in existing curricula roughly at the point where they are naturally functioning. Thus, we prefer the term "appropriate developmental placement" because it is a more accurate descriptor of the process. Regardless, the academic, emotional, and social advantages of "educational acceleration" for the highly talented have been confirmed in every decade since the 1920s (Benbow & Stanley, 1996; Pressey, 1946a; Seashore, 1922; Terman, 1925-1956).

Over most of the 20th century, however, assessing intellectual precocity largely pertained to using general intellectual abilities for forecasting general academic achievement and placement. Although this was an important first step, which has been validated over long time frames (Cronbach, 1996; Holahan & Sears, 1995), it is not useful for tailoring educational interventions toward specific needs. Recent advances stemming from more refined individual-differences measures appear to offer much more.

Modern Empirical Advances

During the past two decades, some consensus has emerged regarding the nature and structural organization of cognitive abilities (Carroll, 1993; Gustafsson & Undheim, 1996), interests (Day & Rounds, 1998; Holland, 1996), and personality (Goldberg, 1993; McCrae & Costa, 1997) in adult populations. More recently, verisimilitude for these models has generalized to intellectually gifted young adolescents. It seems that the intellectually precocious are precocious in many ways. For them, results of conventional psychometric assessments of cognitive abilities, interests, and personality appear to be similar to those of adults (Achter, Lubinski, & Benbow, 1996; Achter, Lubinski, Benbow, & Eftekhari-Sanjoni, 1999; Benbow, 1992; Benbow & Lubinski, 1997; Lubinski, Benbow, & Ryan, 1995; Lubinski, Schmidt, & Benbow, 1996; Schmidt, 1998; Schmidt, Lubinski, & Benbow, 1998). Because of this, psychometric assessments initially designed for adults can facilitate positive development among gifted youth.

Abilities

Most importantly, the hierarchical organization of cognitive abilities — a general factor supported by a number of group factors (e.g., mathematical, spatial, verbal) — reveals the same structure among intellectually talented young adolescents as it does in random samples of adult populations. The intellectually talented tend to develop the eventual adult structure at an early age (hence, the label precocious). Moreover, although we have known for decades that individual differences within the top 1 percent of general intelligence have important educational implications, we now know that the same is true for some specific abilities (Benbow, 1992). Mathematical, spatial, and verbal reasoning abilities have differential and incremental validity for predicting relevant educational-vocational criteria beyond general intelligence (Achter et al., 1999; Humphreys, Lubinski, & Yao, 1993).

Stanley (1996; Keating & Stanley, 1972) was among the first to extend the early efforts of Hollingworth and Terman, who focused on intensity appraisals of general intelligence (IQ), to appraising specific abilities (group factors). Through his Study of Mathematically Precocious Youth (SMPY), beginning in 1971, Stanley documented the importance of more refined intellectual assessments. SMPY used the College Board Scholastic Aptitude Test (SAT) to examine the intensity of precocity among 12-year-olds who were "bumping their heads" on the ceilings of age-calibrated tests routinely administered to them in their schools. Prior to the 1970s, having 12- or 13-year-olds take the SAT for educational planning was essentially unheard of, but today, largely in response to Stanley's groundbreaking work, approximately 200,000 seventh- and eighth-graders take the SAT annually and have their abilities profiled.

Organizers of talent searches seek out seventh- and eighth-graders scoring in the top 2 to 5 percent on age-calibrated standardized tests to take the SAT (or other college entrance exams; Benbow & Stanley, 1996). Interestingly, these students generate SAT score distributions indistinguishable from random samples of high school seniors (Benbow, 1988). Similarly, the SAT is differentially valid for these students, just as it is for college-bound high school students. Students whose talents are primarily in mathematical relative to verbal reasoning tend to gravitate toward quantitatively demanding areas, whereas students primarily talented in verbal relative to mathematical reasoning tend to seek out disciplines more in line with their intellectual strength. Of course, there are exceptions.

When gifted students are placed in environments corresponding to their abilities (e.g., summer residential programs conducted by talent-search organizers), amazing achievement can emerge. For over 20 years it has been shown that highly able students routinely assimilate a full year of a rigorous high school course (e.g., chemistry, Latin, mathematics) in three weeks. These accomplishments have been replicated widely and are well documented (Benbow & Lubinski, 1996; Benbow & Stanley, 1996). Such programs receive positive subjective reports from participants (Benbow, Lubinski, & Suchy, 1996) and demonstrate positive long-term benefits (e.g., Swiatek & Benbow, 1991a, 1991b). We believe, however, that even better outcomes can be achieved if preferences are also considered when matching students to educational environments.

Preferences

Recent empirical findings allow us to refine appropriate developmental placement beyond multiple abilities. That is, just as work over the 1970s and 1980s documented the utility of assessing specific abilities among the gifted (for educational planning), research during the 1990s demonstrated the same potential for certain nonintellectual attributes. Educational and vocational interests seem to be sufficiently differentiated (Achter et al., 1996), longitudinally stable (Lubinski et al., 1995, 1996), and construct valid (Achter et al., 1999; Schmidt et al., 1998) to be useful for this special population by the time its members reach the age of 12 years. We can forecast not only what gifted youth are likely to be best at but also what they are most likely to enjoy. Because exceptional achievement is more likely to emerge when individuals follow their "passion," this advance has important implications for nurturing positive development.

Holland's (1996; Day & Rounds, 1998) robust hexagonal model for describing the structure of adult vocational interests can be applied to intellectually gifted adolescents (Lubinski et al., 1995; Schmidt et al., 1998). The acronym RIASEC in Holland's model is the dominant outline of vocational interests today. RIASEC stands for realistic (works with things and gadgets, works outdoors), investigative (academically orientated, interested in scientific pursuits), artistic (prefers unstructured environments and opportunities for self-expression), social (enjoys people contact and working with and doing things for people), enterprising (is persuasive and a corporate climber, takes on leadership roles), and conventional (conforms to office practices, prefers structure and knowledge of what is expected). These dimensions are multifaceted and, for many purposes, important to decompose (Schmidt et al., 1998). However, as a general outline, RIASEC works well for adults and intellectually talented adolescents in locating environments where passions are likely to be reinforced and actualized.

Although cognitive abilities are more multidimensional than general intelligence supported by quantitative, spatial, and verbal abilities, and although interests extend beyond the six RIASEC dimensions discussed here, these personal attributes are among the most significant personal determinants of educational and vocational choice (Dawis, 1992; Lubinski, 1996). Collectively, they provide a way to think about the multifaceted nature of cognitive and motivational issues found in highly able adolescents. For this special population, we suggest that educational counseling begin with assessment of at least these individual differences. Some may argue that to do so at an early age pigeonholes students, but that is not necessarily so. Rather, these dimensions are tools for evaluating choices and opportunities for personal development that are present at an earlier age. Although interest profiles can and do change among the gifted from early adolescence to adulthood, there is enough stability and validity to consider them flexible guideposts. In the contexts of other attendant life pressures, some of which may conflict (e.g., peers, parents, teachers) with one's self-concept (see below), this information may be clarifying. Because intellectually talented adolescents appear to think seriously and meaningfully about educational and career choices at an earlier than typical age (Achter et al., 1996), these assessments provide a conceptual framework for evaluating their experiences across contrasting learning and work settings. Next, we provide a synthetic model for combining ability and interest information in a cohesive and theoretically meaningful way.

TWA

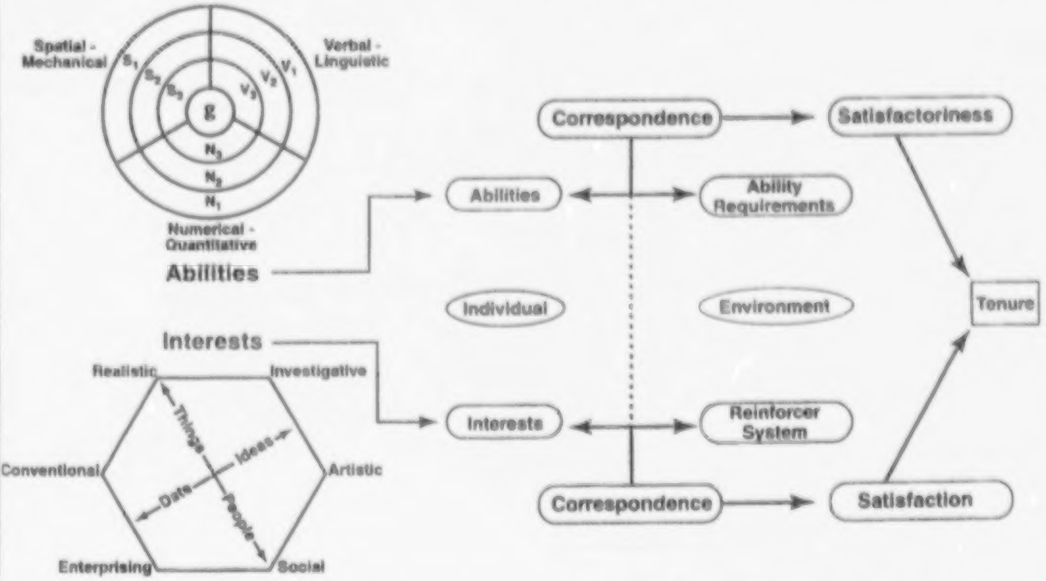
TWA was designed for adult populations and the world of work. TWA is useful for organizing psychometric findings on ability and interest dimensions to facilitate optimal development (see Figure 1). To the left of the conventional TWA model in Figure 1 (Dawis & Lofquist, 1984), we have two well-supported models of cognitive abilities and interests. On the top left side is a familiar arrangement of the major dimensions of cognitive abilities: numerical-quantitative, spatial-mechanical, verbal-linguistic, and their communality, general intelligence (using radex scaling; Lubinski & Dawis, 1992; R. E. Snow & Lohman, 1989). On the bottom left side of Figure 1 is Holland's (1996) RIASEC model.

Because the same variables determine educational and vocational adjustment and, as we saw above, because intellectually talented young adolescents are developmentally mature, we combined information from both sources to view the gifted more multidimensionally. Specifically, we have aligned cognitive abilities and interests with TWA and extended this amalgamation to the educational planning for precocious youth (Achter et al., 1996; Benbow & Lubinski, 1997). Next, we describe how TWA works.

According to TWA (Dawis & Lofquist, 1984; Lofquist & Dawis, 1991), educational and vocational adjustment involves two major dimensions of correspondence: satisfactoriness (competence) and satisfaction (fulfillment). The former is determined by the correspondence between abilities and the ability requirements of the environment. The latter is determined by correspondence between personal needs and rewards provided by the environment. To the extent that satisfactoriness and satisfaction co-occur, the person and environment are said to be in harmony. Both are motivated to continue to interact with one another, because it is to their mutual advantage, and tenure (a longitudinally stable person-environment relationship) occurs. Take, for example, the situation of students who are heavily recruited (by environments) and the educational institutions that are highly sought after (by students). Both work hard to "find" each other

Figure 1

The Theory of Work Adjustment (TWA) Combined With the Radex Scaling of Cognitive Abilities (Upper Left) and the RIASEC Hexagon of Interests (Lower Left) for Conceptualizing Personal Attributes Relevant to Learning and Work


Spatial - Mechanical
Verbal - Linguistic
S1
S2
S3
V1
V2
V3
g
N3
N2
N1
Numerical - Quantitative
Abilities
Correspondence
Satisfactoriness
Abilities
Ability Requirements
Individual
Environment
Tenure
Interests
Realistic
Investigative
Interests
Reinforcer System
Conventional
Artistic
Things
Ideas
Data
People
Correspondence
Satisfaction
Enterprising
Social

Note. The dotted line running down the individual and environment sectors of TWA illustrates that TWA places equal emphasis on assessing the personal attributes (abilities and interests) and assessing the environment (abilities requirements and reward structure). RIASEC is an acronym for realistic, artistic, social, enterprising, and conventional; vocational interests covary to the extent to which they share proximity with the hexagon. For cognitive abilities, V=verbal-linguistic, N=numerical-quantitative, and S=spatial-mechanical content; subscripts with these letters represent the level of complexity, with larger subscripts reflecting greater complexity. Cognitive abilities covary to the extent that they share content and complexity.

(Zuckerman, 1977); and both work hard to "keep" each other.

One important feature of TWA is that it places equal emphasis on assessing the person and assessing the environment. Ideal environments are those that match the personal attributes of individuals. Optimal development occurs when people's needs are met and their abilities are appropriately challenged. Students who are primarily strong in verbal reasoning versus quantitative or spatial reasoning tend to gravitate toward domains (e.g., disciplines, occupations) that require appreciable levels of their most salient talent. For example, fields like engineering tend to attract people with primary strengths in spatial visualization and quantitative reasoning abilities, whereas the humanities tends to attract people with primary strengths in verbal abilities (Achter et al., 1999; Humphreys et al., 1993). Sometimes, however, interests can motivate educational and vocational choices that do not draw on strengths. It is not unusual for people to strongly desire to do things that they cannot do (e.g., singing when they lack a fine voice); simultaneously, most people are competent at many things that they would prefer not to do. Yet, for most well-adjusted students and employees, their ability and preference constellation aligns with the ability requirements and rewards of their learning or work purview.

TWA is also helpful in illuminating other psychological concepts useful in analyzing how people approach contrasting learning and work environments (Dawis, 1996a) such as self-concept, self-efficacy, internal locus of control, and self-esteem. All of these concepts involve perceptions of self. To a large extent, what we mean by a self-concept reflects our perceptions of our abilities and skills and our beliefs about our needs and values. Self-concept is dependent on behaviors we value (competencies) and people or things we care about (personal needs). Behaviors, people, and things we are indifferent to are irrelevant to our self-concept. Beliefs about the extent to which our abilities are effective (i.e., self-efficacy beliefs) in meeting our needs are critical to our self-concept. This, in turn, involves the perception of the locus of control for reinforcement (i.e., events that meet needs). An internal locus of control develops to the extent that individuals perceive themselves as instrumentally effective in getting their needs met.

One's personal evaluation of how these aspects of self interconnect, or the evaluation of self, engenders feelings of satisfaction or dissatisfaction with oneself, which constitute one's level of self-esteem. Providing intellectually talented students with valid psychometric information about their abilities and interests imparts critical information on how one's self-concept is being defined. Making developmentally appropriate learning opportunities available for the gifted, opportunities that are congruent with valid information and responsive to the students' differential learning rates, is likely to lead to feelings of satisfaction with self and the development of an internal locus of control. Hence, TWA provides students with tools for not only a better understanding of themselves (and their contrasting reactions to different environments) but also a framework for taking charge of their personal development.

Empowerment in the area of personal development has long been one of the major goals of educational and vocational counseling from the individual differences tradition (Dawis, 1992, 1996b; Lubinski, 1996; Tyler, 1992). Assessing the salient personal attributes of clients, focusing on strengths (while acknowledging relative weaknesses), and using these aspects of self to solidify life values (Tyler, 1992; Williamson, 1965) are the conceptual antecedents from which TWA evolved. Knowledge about enduring psychological characteristics is critical in evaluating contrasting environments for development and making decisions about which opportunities are likely to be most personally meaningful. When these ideas are combined with developmental work on niche building (Bouchard, 1997; Scarr, 1992, 1996) — how people seek out and strive to create learning, social, and work environments corresponding to their personal attributes (Bouchard, 1997) — we begin to gain a purchase on how precocious cognitive development unfolds. Perhaps we also come to understand how it should be nurtured.

Intellectual Development: TWA Informed by PPIK Theory

Ackerman (1996; Ackerman & Heggestad, 1997) has proposed an intriguing model of adult intellectual development that is relevant to our discussion. It orchestrates abilities-as-process with personality and interest dimensions to conceptualize the acquisition of cognitive content (i.e., knowledge) throughout the life span. Here, content denotes the pedagogical aspects of learning (i.e., knowledge), whereas process is more restricted to the psychological power of intellect (i.e., general intelligence, or possibly working memory capacity; Carpenter, Just, & Shell, 1990; Kyllonen & Christal, 1990). Ackerman's (1996) theory is called PPIK, because it integrates intelligence-as-process, personality, interests, and intelligence-as-knowledge. Interests and personality attributes serve to channel the development of knowledge structures down differential paths (e.g., C. P. Snow's, 1967, two cultures, "humanists" vs. "scientists"), whereas intelligence-as-process determines the complexity of knowledge assimilated (i.e., one's general potential for intellectual sophistication).

Teaming interests and personality dimensions with intelligence-as-process has empirically confirmed differential predictions regarding the developmental trajectory of crystallized abilities (i.e., specific knowledge structures). Moreover, this model is also insightful for understanding why individuals with similar cognitive profiles can and frequently do vary widely in the particulars of their knowledge base. They do so because they differ on noncognitive personal attributes relevant to the development of specific skills and knowledge; they also have different opportunities. To support these ideas, Ackerman (1996; Ackerman & Heggestad, 1997) has compiled ability-interest, ability-personality, and interest-personality correlates from the psychological literature on adult populations. Through narrative review, meta-analytic inquiry, and investigations of self-reported strengths four (across-attribute) ability-interest-personality trait complexes were identified: social, clerical/conventional, science/math, and intellectual/cultural.[1]

The science/math and intellectual/cultural trait complexes provide empirical support for C. P. Snow's (1967) two cultures: Intellectual/cultural, for example, consists of light correlations between measures of verbal ability and aesthetic and investigative interests, whereas science/math consists of light correlations between math and spatial abilities and realistic, investigative, and social (reversed) interests. This patterning has recently been replicated in intellectually gifted young adolescents (Schmidt et al., 1998). These trait complexes, although comprising modest positive and negative correlations (.25-.30), nevertheless generate ostensibly different subpopulation "types" when identification is restricted to one specific ability (mathematical, spatial, or verbal reasoning) and selection is stringent (see below).

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[1] Trait complexes are akin to R. E. Snow's (1991; R. E. Snow, Corno, & Jackson, 1996) aptitude complexes for examining different treatment modalities in educational settings and Dawis and Lofquist's (1984) *taxons* of ability and preference constellations used to conceptualize the person component of the interaction between individuals and environments. All of these ideas highlight the importance of combining affective and cognitive variables for both basic and applied research as well as practice.

According to PPIK theory, for most students, throughout the preadult years, general intelligence tends to override other predictors of academic performance because academic criteria are relatively uniform from kindergarten through 12th grade (i.e., all students are exposed to essentially the same educational curriculum). However, as people mature, they are allowed to make more choices and move more freely into and out of various environmental niches as a function of their own choices. In contrast to adolescence, adulthood brings more freedom of choice, and people begin to specialize. According to a number of developmental theorists (Bouchard, 1997; Reiss, Neiderhiser, Hetherington, & Plomin, 2000; Rowe, 1994; Scarr, 1992, 1996), choices are made to conform to one's relatively enduring personal attributes. As people select niches tailored to their enduring psychological characteristics, the particular competencies and knowledge structures acquired become more dependent on the level and patterning of cognitive abilities, interests, and personality.

Moreover, with adulthood people not only become freer to make choices about their development, but the intensity of their development also comes more under their control. How people develop becomes less dependent on a standard curriculum and more a function of the types of environmental niches chosen to migrate from, enter into, and operate within. This is precisely why PPIK theory holds appeal for intellectually talented youth: With relatively little effort, they are able to master the typical educational curriculum quickly, relative to their chronologically age-matched peers. This opens up an array of possibilities for further development. Yet, precisely how the gifted choose to develop (when developmentally appropriate learning opportunities are freely provided) is not (and should not be) random: It is psychologically systematic. The development of gifted students tends to be driven by the same underlying individual differences found in adults and is predictable with conventional psychometric tools. Making explicit the attributes that structure these students' development is likely to help them make better choices and reduce the number of false starts.

Further, PPIK theory shows how TWA works within a developmental context to explain the emergence of eminence. Because eminent individuals tend to find their career paths early and must spend huge amounts of time mastering their domain (Roe, 1952; Walberg, 1969; Zuckerman, 1977), using TWA to help talented youth make wise decisions becomes good practice. To be sure, not all talented youth become eminent — and many should probably not be encouraged to do so — but those who do tend to begin the talent development process early. To more fully appreciate creative, high-achieving individuals, however, we need at least one other class of variables: *Conative* determinants are critical for understanding truly exceptional accomplishments.

Magnitude of Development

Both TWA and PPIK theory stress conative factors for conceptualizing individual differences in development. These determinants are related to individual differences in drive and energy — not the substance of behavior per se but rather its intensity and temporal dynamics. Familiar labels include capacity for work, industriousness, perseverance, and zeal. Across almost all disciplines and occupations, conative attributes are among the most conspicuous factors that distinguish truly exceptional performers from their professional peers. Even in less glamorous arenas, this class of variables is important in understanding performance more generally (e.g., under- and overachievement in routine educational settings).

Clearly, there are individual differences in the amount of energy that people can or are willing to invest in their development. To assess these differences, Ackerman has discussed and developed a measure for a construct he calls typical intellectual engagement (Goff & Ackerman, 1992). In a similar vein, TWA has offered four aspects of personality style (Dawis & Lofquist, 1976) to characterize the temporal characteristics of behavior: celerity, endurance, pace, and rhythm. In both PPIK theory and TWA frameworks, concentrated effort, time on task, and energy invested play a large role in the development of expertise and knowledge structures. In the psychological literature, consideration of conative variables goes back to at least Webb's (1915) formulation of will, but Galton (1869) also discussed zeal and the capacity for work as critical components for truly exceptional performance. Essentially all modern psychologists studying the topic of talent development have noted the intense devotion to practice, study, and work that exceptional performers manifest (Ericsson, 1996; Eysenck, 1995; Gardner, 1993; Jackson & Rushton, 1985; Simonton, 1988, 1994). Yet, the magnitude of individual differences manifested on these volitional attributes is frequently underappreciated.

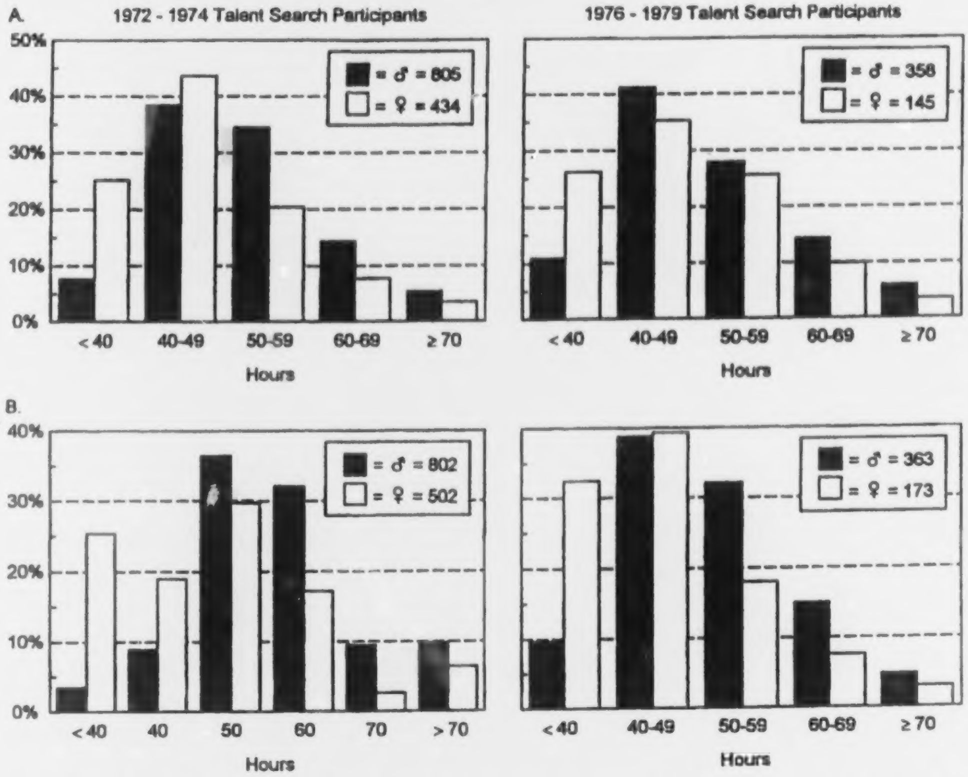
To highlight this point, we present Figure 2, which contains data from over 1,700 participants from SMPY's 20-year follow-up (Lubinski & Benbow, 1994). All participants were assessed with the SAT before they were 13 years old, during the 1970s; they scored in the top 1 percent in quantitative reasoning ability for their age group (many had even more exceptional SAT-Verbal scores). At age 33, the participants were first asked how much they would be willing to work in their "ideal job" and then asked how much they actually do work. These data reveal huge individual differences. For better or worse, these individual differences will surely engender different performance and work-related outcomes.

The Emergence of Eminence

When dealing with exceptionality, one is sometimes moved to consider different kinds of intelligence or different models, because the kinds of problems

Figure 2

Two Questions About Work Taken From the Study of Mathematically Precocious Youth's 20-Year Follow-Up Questionnaire



Note. Participants were identified at age 13 as having quantitative reasoning abilities within the top one percent of their age group. At age 33, they were asked (a) how many hours per week they typically worked, by gender (excluding homemakers), and (b) how many hours per week they were willing to work, given their job of first choice. Please note that the 1972-1974 participants were given six temporal options, whereas the 1976-1979 participants were provided with five choices.

encountered when moving across contrasting disciplines (e.g., art, chemistry, and literature) are so different. Extraordinary accomplishments within these spheres serve only to underscore their uniqueness. They appear qualitatively different. Given this, might it make sense to think of Picasso, Curie, and Shakespeare as having different kinds of minds (Gardner, 1993)? What about Gandhi or Freud, with the unique problems they addressed and the way they approached life more generally? Perhaps different types of intelligence are necessary to conceptualize their spectacular achievements. There is probably some truth to this, especially given what we know about the cerebral organization and cognitive functioning of gifted individuals with different strengths and relative weaknesses (Dark & Benbow, 1991; Nyborg, 1994; O'Boyle, Benbow, & Alexander, 1995). Yet, it would still be good to see how far the psychology of individual differences can take us (Messick, 1992). It is quite possible that when exceptional performances undergo critical analysis, what is uncovered is not unique qualities but rather more of certain qualities (e.g., affective, cognitive, conative) that lead to qualitative differences in knowledge content and, perhaps, different types of eminence.

Consider the following illustration. If we assume true correlations between quantitative, spatial, and verbal reasoning abilities are all around .75, this leaves much room for profile variability. Indeed, appreciable variability is expected, particularly when selection is stringent and exclusively restricted to one ability dimension. For example, someone four standard deviations above the norm on verbal reasoning abilities, or who is the top 1 in 30,000, would clearly be in possession of the specific cognitive ability for greatness in law, literature, or philosophy, among other verbal-linguistic disciplines. Yet, this individual might not be distinct from many colleagues at major universities on other specific abilities. The mean expectation for this person's quantitative and spatial reasoning abilities (with RvQ = Rvs = .75, and with V four standard deviations above the norm) is 3 standard deviations above the norm (i.e., .75 X 4 = 3), or the top 1 or 2 in 1,000.

Now, to be sure, being among the top 1 or 2 in a group of 1,000 is impressive, but it is not nearly as impressive as being the top 1 in 30,000 and really is not so awfully rare at major universities. This amount of intellectual diversity is the expectation for anyone so verbally exceptional. It also would be the amount of diversity anticipated (under the same assumptions) for someone as exceptional in quantitative or spatial reasoning. Three groups of individuals, selected for their exceptionality in quantitative, spatial, or verbal reasoning appear quite distinct from one another and in some important respects they are. However, their distinctiveness may overshadow their common generic stock.

Is it possible that creators of exceptional intellectual products are not nearly so enigmatic as typically supposed? Can measures associated with major dimensions of cognitive abilities capture their distinctiveness quantitatively? Might they also explain how quantitative differences in individual-differences profiles develop into qualitative differences in knowledge structures? Plausibility for this idea is intensified when it is recalled that specific abilities "pull" with them unique clusters of noncognitive personal attributes (Ackerman, 1996; Ackerman & Heggestad, 1997; Ackerman & Rolfhus, 1999), sometimes in diametrically opposed ways. Recall Ackerman's (1996) cultural/intellectual and science/math trait complexes, which have recently been replicated in gifted adolescents.

In Schmidt et al.'s (1998) study of gifted adolescents, spatial abilities covaried approximately .25 with realistic interests (working with things) and -.25 with social interests (working with people). If spatially talented students are selected, using a cutting score of merely 2 standard deviations above the mean, the following would be anticipated: The resulting sample will average half a standard deviation above the mean in interests in working with things (2 X .25 = .50) and half a standard deviation below the mean in interests in working with people (2 X -.25 = -.50). Collectively, these 2 patterns would cover a full standard deviation difference in interests for people versus things (see the RIASEC component in Figure 1). These differences would be conspicuous enough to motivate categorical considerations. They would certainly generate stereotypic impressions of "different types" if compared with members of highly talented groups selected on verbal or quantitative abilities, which covary more deeply with other interests. Now consider the result if the cutting score had been 4 rather than 2 standard deviations above the norm.

Selecting two groups at the extremes on any pair of the major markers of general intelligence (math/verbal, math/space, verbal/space) eventuates in multiple group differences on other major individual-differences dimensions. Moreover, such group differences are often sufficiently pronounced to stimulate reasonable observers to consider discontinuities. Yet, as we have seen, these constellations could stem from continuous gradations within an underlying multivariate space of systematic sources of individual differences with no discrete boundaries. It could turn out that exceptional achievements are "simply" outcomes of optimal blends of extraordinary levels of normative attributes (affective, cognitive, and conative) that found their way to developmentally supportive environments. This theory prompts two questions: What is a supportive environment, and how do supportive environments operate to sustain positive psychological growth over extended time frames?

Correspondent Learning Environments Foster Psychological Well-Being; Discorrespondent Learning Environments Foster Psychological Pain

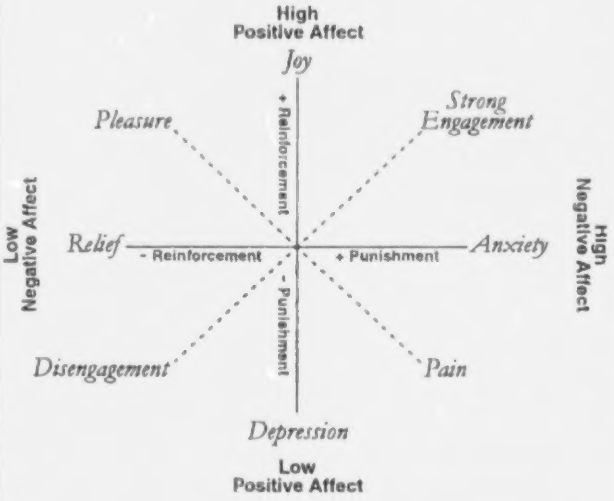
For environments to support the amount of psychological growth needed for the emergence of eminence, positive psychological experiences are required to nurture the development of expertise, skill, and knowledge structures through a fairly immediate mechanism: Several investigators have estimated that this development takes approximately 10 years of concentrated effort. For example, a decade of up to 70-hour work weeks is required before someone with the proper configuration of attributes (Eysenck, 1995; Jensen, 1996) develops the crystallized skills needed for moving the boundaries of a discipline forward (Ericsson, 1996; Gardner, 1993; Simonton, 1988, 1994; Zuckerman, 1977). How might these sustaining mechanisms operate? Consider the following: To the extent that students are placed in correspondent learning and work environments, they are more likely to experience a greater density of reinforcing events and, simultaneously, are less likely to experience punishing events, including boredom. These environments encourage maximal positive development. More specifically, they enhance the likelihood of experiencing psychological well-being (the affective concomitant of reinforcing operations) and attenuate the chances of experiencing psychological pain (the affective concomitant of punishing operations).

What events constitute punishment versus reinforcement depends on the individual. Just as learning environments may be considered highly challenging or boring depending on the student, the same environment may be seen as exciting or aversive from a motivational — reinforcement or punishment — point of view. This is why it is important to assess individual differences in abilities and interests initially. To the extent that satisfaction and satisfactoriness are not achieved, two forms of psychological distress ensue: one associated with problems (when performance is unsatisfactory), the other associated with pain (when needs are not met). Therefore, psychological problems are characteristic of a lack of correspondence between the individual's abilities and the ability requirements of the environment, a mismatch causing problems for the individual and the environment. Psychological pain, on the other hand, results from a lack of correspondence between the individual's needs and the rewards mediated by the environment.

Figure 3 depicts a well-replicated two-dimensional framework for studying affect defined by positive and negative emotionality, two relatively independent dimensions (Tellegen, Watson, & Clark, 1999; Watson & Tellegen, 1985). Positive and negative emotionality are stable individual-differences dimensions associated with positive and negative affect, but nevertheless they can manifest wide state variations (Zevon & Tellegen, 1982). Fluctuations in affect systematically covary with reinforcing and punishing stimuli. These two dimensions are helpful for. understanding changes in affect associated with reinforcement (well-being) and punishment (pain). One goal of educational and vocational counseling from a TWA framework is to maximize the former and min-

Figure 3

Consensual Mood Structure



Note. Adapted from Watson and Tellegen's (1985) outline of the structure of affect, with the additions of two contingencies of punishment (+ for positive punishment and - for negative punishment) and reinforcement (+ for positive reinforcement and - for negative reinforcement). These punishment and reinforcement contingencies illustrate how exogenous events serve to moderate affect. Specifically, this figure is adapted from "Toward a Consensual Structure of Mood," by D. Watson and A. Tellegen, *Psychological Bulletin, 85*, p. 221. Copyright 1985 by the American Psychological Association. Adapted with permission.

imize the latter.

Psychologically, there are at least two components to pain and two components to well-being (see Figure 3). Psychological pain follows two kinds of punishing conditions, namely, positive and negative punishment, which are the presentation of aversive stimuli (anxiety) and the removal of appetitive stimuli (depression), respectively. Psychological well-being, on the other hand, follows two kinds of reinforcing conditions, namely, positive and negative reinforcement, that is, the presentation of appetitive stimuli (joy) or the removal of aversive stimuli (relief).

TWA can help in identifying environments that are ideally tailored toward augmenting one's overall psychological well-being while simultaneously attenuating the likelihood of experiencing pain. More specifically, one's affect fluctuates as a function of the density of punishing and reinforcing events experienced. Correspondent learning environments tend to minimize the former and maximize the latter. Placing students in learning environments congenial with their abilities and interests has multiple direct advantages. For example, the curriculum moves at a pace commensurate with learning rates, so more learning occurs and motivation builds. Also, the topics of most interest are introduced at developmentally appropriate times, so more enjoyment is experienced, which augments motivation. Moreover, such environments also foster advantageous indirect benefits, by placing talented students who enjoy academic challenges in social milieus where they feel free to express their genuine love of learning and receive peer support rather than ridicule for doing so (Benbow & Stanley, 1996). In sum, satisfaction and satisfactoriness operate to maximize positive and negative reinforcement and minimize positive and negative punishment (see Figure 3). Herein is the mechanism that sustains commitment to developing skills over extended time frames. This applies not only to the development of eminence but also to less noteworthy accomplishments like securing an advanced degree.

Support for these ideas is found in the subjective reports of intellectually talented students who have had an appropriate developmental placement experience (Benbow et al., 1996; Benbow & Stanley, 1996).[2] The reports tend to be overwhelmingly positive. In addition, our experience over the past 10 years with summer residential programs for the gifted has revealed that 40% of the participants return the following summer for further educational experiences tailored toward their capabilities and interests. We do, however, observe a robust gender difference that is nationally characteristic of summer residential programs for the gifted. Although both boys and girls evaluate these opportunities positively, girls tend to report more positive effects. Our interpretation of this finding is that peer pressure on gifted girls is harsher in contrast to the pressure experienced by gifted boys. Hence, when talented girls are placed in an environment where the pressure not to achieve is essentially absent, they not only enjoy the reinforcing experience but also are especially relieved by the absence of punishment. Indeed, they often report finally being able to "be themselves."

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[2] For evaluating meaningful outcomes for gifted youth, some remarks about realistic criteria are in order. The study of extraordinary intellectual abilities invariably turns to genius, an infinitely small subset of the intellectually talented population (e.g., Einstein, Picasso, and EGot). They represent approximately one in a million people. Even so, some have considered the forecasting of genius to be a critical goal of talent development procedures. However, this criterion is unrealistic. The base rate for genius is simply too miniscule (and the chance factors too harsh) to make doing so justifiable. What is more, all of the necessary endogenous and exogenous factors conducive for this degree of development have to co-occur in the proper zeitgeist; the culture has to be receptive to the products generated. To be sure, spurred on by optimism spawned by the early testing movement, Terman (1925; Terman & Oden, 1959) probably fostered this criterion himself by unfortunately calling his longitudinal study *Genetic Study of Genius*. We now know that there is much more to genius than simply ability. Models are available for better understanding how genius does indeed come about, however; interestingly, there is a consensus about certain attributes (Eysenck, 1995; Gardner, 1993; Jensen. 1996; Simonton, 1988, 1994; Zuckerman, 1977).

Conceptualizing States of Excellence

In Nicholas Hobbs's (1958, p. 595) list of criteria for becoming "the compleat counselor," he lists first "become a good general psychologist" and remarks "I have been impressed over and over again by the frequency with which pure science psychology provides new directions for various kinds of applied endeavors." In this spirit, we attempt to tie the thread running through TWA's correspondence dimensions, satisfaction and satisfactoriness, to other concepts in psychological literature.

Satisfaction, Satisfactoriness, and Other Psychological Concepts

We suspect that satisfaction and satisfactoriness cut across multiple aspects of life; if we are correct their implications could be very broad. Lofquist and Dawis (1991) supported this idea by linking these two outcomes to Freud's pleasure principle (people seek to avoid pain and achieve gratification, or TWA's satisfaction) and reality principle (i.e., the demands and requirements of the external world, or TWA's satisfactoriness). Tellegen (1981) has spelled out a distinction between two similar mental sets: experiential (or respondent) and instrumental (or operant). As one might infer from Tellegen's distinction, which builds on a Skinnerian framework, Premack's principle runs through these concepts (and is also embedded in TWA): To predict which environments an individual is likely to enter, work in, and thrive in, you must not only know what they can do (their abilities, or capabilities), you must also know what they want (their interests, needs, or motives).

These distinctions all contrast a positive experience, highly reinforcing in and of itself (unconditionally, often outside of any pragmatic utility), with one of more striving, planning, decision making, and active pursuit. Other distinctions loosely coupled with the foregoing include Bakan's (1966) communion and agency, Fromm's (1979) receptive and active modes, Koch's (1956) intrinsic and extrinsic modes, Maslow's (1968) B-Cognition (for being) and

D-Cognition (for doing), and Parsons and Bales's (1955) expressiveness and instrumentality. Can these sets of contrasting concepts help in better understanding the reports of world-class performers about their subjective experiences during or after a brilliant accomplishment? How about other subjective "highs" that co-occur with less spectacular achievements but nevertheless require vigorous concentrated efforts to develop?

The familiar illustration that comes to mind (found in some introductory psychology texts) is the side-by-side photographs used to exemplify self-actualization. One is of a young boy, proudly holding his pet rabbit and the blue ribbon they just earned at the fair. The photograph next to this is typically that of a Nobel laureate and the trophy for this achievement. The adjacent photographs poignantly illustrate how similar affective states can co-occur with highly disparate accomplishments. Yet, these achievements are developmentally appropriate and tailored to the abilities and interests of the participants; they also undoubtedly share similar affective qualities. Can the model we have been developing shed light on such phenomena? We think so.

Effectance Motivation

White (1959) has argued that prolonged bouts of problem-solving behavior directed toward a distant goal serve to generate acquired motives:

> I shall argue that it is necessary to make competence a motivational concept; there is a competence motivation as well as competence in its more familiar sense of achieved capacity. Moreover, when this behavior gives satisfaction it involves the transaction of person and environment (the effect each has on the other). (p. 318)

White (1959) refers to the development of the type of motivation (motivation that develops from having an instrumental effect on the environment) called effectance. Importantly, effectance is self-generated endogenously rather than being exogenously administered. It appears to be an emergent person-environment phenomenon:

> It is constantly circling from stimulus to perception to action to effect to stimulus to perception, and so on around; or, more properly, these processes are all in continuous action and continuous change. Dealing with the environment means carrying on a continuing transaction which gradually changes one's relation to the environment. Because there is no consummatory climax, satisfaction has to be seen as lying in a considerable series of transactions, in a trend of behavior rather than a goal that is achieved. It is difficult to make the word "satisfaction" have this connotation, and we should do well to replace it by "feeling of efficacy" when attempting to indicate the subjective and affective side of effectance. (pp. 321-322)

Hence, genuine feelings of self-efficacy are the result of many behavior-dependent products or, more specifically, products dependent on competent (effective) behavior. This supports Allport's (1946) insight: positive development unfolds not only because of what individuals do but also because of the effects their behaviors have on the environment. We hypothesize that teaming dominant abilities with regnant interests and concentrating development toward a correspondent goal enhances the development of effectance motivation.

Csikszentmihalyi (1993) has noted interconnections between his concept of flow and many other concepts, including Maslow's (1968) *peak experiences*. Could it be that underpinning much of what is meant by experiencing flow or having a peak experience is the subjective experience of effectance motivation — more specifically, an experiential state engendered when complex performances emerge in highly correspondent environments, performances that require an extraordinary commitment of concentrated effort to develop and for which these extraordinary efforts contribute to the development of sustaining opponent processes (Landy, 1978; Solomon, 1980)? This seems to follow from White's (1959) position on the development of effectance motivation, something not unlike a "mechanism becomes drive" phenomenon, which engages concurrently with or after a seemingly effortless impressive performance.

Educational Implications

If the above analysis has merit, it suggests that educators should concentrate on developing students' satisfactory behaviors, which are structured around students' most salient attributes, and finding environmental niches within which they are likely to be genuinely reinforced (for developing their capabilities) rather than focusing on feelings (and reinforcing indiscriminately). Flow experiences would then engender cascades of indirect effects, not only for the gifted but for all students. This is because if this analysis has merit, it would be impossible to feel depressed or have low self-esteem while experiencing flow. Maybe educators who shifted away from the development of skills to the development of positive feelings did students a disservice. At least White (1959) appeared to believe that in their most genuine form, feelings of self-efficacy co-occur with or result from the development and execution of complex skills. Perhaps educators should concentrate on recognizing and reinforcing successive approximations toward instrumentally effective skills. That is, they should focus on developing the capacities to do the same thing a little better every day, or continuous improvement, which the Japanese call *kaizen* (Secretan, 1997, p. 49).

With respect to developing true excellence, there probably will never be any quick fixes. Excellence takes time. Perhaps it would be good for educators and policy makers to acknowledge this more frequently, as others already have. For example, when it was pointed out to Ignatz Jan Paderewski (the great Polish pianist) that he was a genius, his response was "Yes, and before that I was a drudge."

Educators probably should focus not on the aforementioned unconditional feeling states but rather on their conditional instrumental counterparts whose development naturally engenders them. Being interested in developing effective behaviors and reinforcing their occurrence is likely to foster positive psychological development. Being unwilling to differentiate between effective and ineffective performances and unwilling to differentially reinforce them is likely to foster something else.

Broader Issues in Counseling and Educating the Gifted

Factors other than empirical evidence often contribute to whether sound research findings are implemented in practice. In this regard, Hobbs's (1958) "The Compleat Counselor" is particularly worth reading. Not infrequently, attendant social issues determine how educational and psychological services are reacted to and distributed (Coleman, 1990-1991; Cronbach, 1975b; Humphreys, 1991). Hobbs (1958) recommended that we attend to issues such as the cultural climate and the tenor of the time. Appreciation of these determinants is not only likely to enhance our effectiveness as practitioners, but doing so may even attenuate the intensity of Cronbach's (1975a) pessimistic appraisal of empirical generalizations in the social sciences (i.e., their "short half-life"). Actually, the psychology of individual differences has amassed an impressive array of empirical generalizations (Lubinski, 1996, 2000), for which highly efficacious interventions that meet the special needs of intellectually talented students are but one example.

In many respects, society has had a volatile relationship with the gifted throughout most of this century (Benbow & Stanley, 1996). One likely reason for this is that educational systems are confronted with an array of overwhelming negative psychological exigencies. In the context of a society replete with drug running, teen pregnancy, and gross underachievement among various demographic groupings, the gifted do not surface as a priority. Relatively speaking, the gifted appeared to be doing just fine. However, they could have been doing much better (Benbow & Stanley, 1996), and society likely would have profited from it. During the 1950s, a lot was known about the special needs of gifted students (Witty, 1951), and distinguished educators and psychologists laced their professional writings with this information. They noted not only the direct effects of tailoring educational curriculum to individual differences in learning rates (Hollingworth, 1926, 1942) but also the positive indirect effects for society (Paterson, 1957; Pressey, 1946a, 1946b; Terman, 1954). In discussing the conspicuous neglect of gifted students and how it was in society's best interest to correct for this, Hobbs (1958) suggested that counseling psychologists should take a leadership role:

> The compleat counselor will also be asked to help in the development of new generations of people trained to levels commensurate with their abilities. We

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> have been prodigal of talent in America, being content to let lie fallow or refuse to cultivate much of our human potential. But things were changing even before the launching of the satellites [Sputnik], and gifted children, after years of neglect in education, are all the rage. One cannot but welcome this change in attitude. Though we suddenly see in teachers' magazines and popular periodicals altruistically toned articles stating the case for the gifted child, we should recognize that this sudden interest in intelligence springs from concern with prospects for national survival. I would hope that our compleat counselor would be one of the most effective people in identifying talented youngsters and in helping to plan educational programs to ensure their fullest development. (p. 598)

These remarks point to some corollary social benefits of investing in gifted students while highlighting society's self-interest in responding favorably to their precocity; it is also the thoughtful thing to do for the individual gifted child. This midcentury recognition of gifted students was stimulated by Witty's (1951) *The Gifted Child*, within which Hobbs (1951) made a forceful case for their underappreciation as a human capital resource:

> Citizens and experts alike have not generally become aware of the community's significance, for good or ill, in the life of the gifted child. Perhaps the most promising contribution that this volume can make is to bring the potentialities and the particular needs of the gifted child into prominence. (pp. 164-165)

Witty's (1951) volume was indeed successful in this regard (see Terman, 1954, p. 227) and became a landmark in the gifted literature.

Writings such as these and others were synthesized and enlarged in Williamson's (1965) *Vocational Counseling*. This volume provided a solid foundation (empirical, philosophical, and theoretical) for facilitating talent development for all students. It provided the connecting fiber binding applied individual-differences research in educational and industrial psychology, conjoined their powerful person-environment models, and traced their conceptual antecedents to Paterson, Schneidler, and Williamson 's (1938) *Student Guidance Techniques* and Viteles's (1932) *Industrial Psychology*. Williamson (1965) is an excellent exemplar of positive psychology. He was especially insightful in his description of how to counsel and design learning environments for future intellectual leaders, particularly through the way he drew on philosophical concepts from the Greeks (e.g., *eudaimonia*, doing excellence).

Yet, looking back, it appears that the compelling exigencies of the 1960s and 1970s shifted focus. Neither Hobbs's (1958) recommendations nor Williamson's (1965) systematic compilation of prior decades of applied individual-differences research were widely assimilated by the next generation of scholars. Although important, the work of Hobbs and Williamson was not seen as a priority. Ironically, this turned attention away from those most equipped to solve the most challenging problems encountered in a highly technical, multicultural, ever-changing society. Nevertheless, research on talent development within this tradition — namely, the individual-differences tradition — has continued (Dawis, 1992; Lubinski, 1996): abilities, interests, and personality are assessed to build models for facilitating positive development (Benbow & Stanley, 1996; Dawis, 1996b; Scarr, 1996).

Today, we know much more about the dimensionality of relevant individual differences dimensions germane to the development of exceptional abilities, as well as how to utilize this information in practice (Benbow, 1991; Benbow & Lubinski, 1996, 1997; Benbow & Stanley, 1996; Lubinski & Benbow, 1995; Winner, 1996). This special issue marks a good time to take stock in what we now know about this special population and the magnitude of psychological diversity within it. In all likelihood, this population contains the most promising human capital for solving the social exigencies facing us. Moreover, the TWA framework provides a cogent model for conceptualizing how all applied psychological specialties, when seen in their most ideal form, might be construed: as sequential complements of one another covering the full range of life span development (through lifelong learning). Namely, when contiguously aligned, the applied psychological precincts appear to form a developmental continuum: educational ® counseling ® industrial. Child and adult clinical psychology also form a developmental continuum but focus on maladaptive behavior within or in transitioning between stages. Yet, all of these specialties share a common goal: the scientific study of implementing contrasting opportunities, based on individual differences, with the aim of maximizing positive psychological growth at different stages of life span development. That is the essence of talent development.

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The Javits Gifted and Talented Students Education Program: Background and Funding

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The major federal source of support for education of gifted students is the program authorized under the Jacob K. Javits Gifted and Talented Students Education Act of 1994, Elementary and Secondary Education Act (ESEA) Title X, Part B of Improving America's Schools Act of 1994 (P.L. 103-382). The Javits Act provides grants to state educational agencies (SEAs) and local educational agencies (LEAs), institutions of higher education and other public and private agencies for research and demonstration, model projects, and training activities designed to meet the special needs of gifted and talented students. Although the federal funding level is not large ($6.5 million), model projects developed by the Javits program have been used throughout the U.S. The President's budget for FY2001 requests $7.5 million for the Javits gifted program, and the FY2000 appropriation was $6.5 million. The Javits Gifted program is being considered as part of the ESEA reauthorization. On October 21, 1999, H.R. 2, one of the ESEA reauthorization bills, passed the House, and under Title V, provided amendments to the Javits Gifted and Talented program. On March 9, 2000 the Senate bill, S. 2, the Educational Opportunities Act was ordered reported from the Senate Committee on Health, Education, Labor and Pensions (reported April 12) with amendments to the Javits Gifted program. On May 1 to May 9, 2000 the Senate began floor debate on S. 2 but it has not resumed. This report will be updated as legislation occurs.

Legislative History of the Javits Program

The current federal program for educating gifted and talented students was first established by the Jacob K. Javits Gifted and Talented Students Education Act of 1988, as part of the Hawkins-Stafford Elementary and Secondary School Improvement Amendments of 1988, P.L. 100-297. A federal effort for the gifted existed prior to that time under various titles of the Elementary and Secondary Education Act (ESEA). However, it was the Javits Act, Title IV-B ESEA, that restored separate categorical support, thereby increasing visibility and federal RS-2 support for education of the gifted. The Javits program was reauthorized

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by the Improving America's Schools Act of 1994, P.L. 103-382, and is now Title X- B of ESEA.[1]

The Javits Program

The Jacob K. Javits Gifted and Talented Students Education Act provides discretionary grants to SEAs, LEAs, and other public and private agencies with the purpose of building a nationwide capability to meet the special educational needs of gifted and talented students; to encourage the development of challenging curricula for all students through the appropriate application and adaptation of materials and instructional methods originally developed for the gifted; and finally to supplement the expenditure of state and local funds for education of gifted and talented students.

According to the statute, Javits grants are provided for:

- professional development and model projects including innovative methods for identifying and educating gifted students. (The act stipulates that the Secretary of Education give priority to projects for gifted students not normally identified through traditional assessments, including economically disadvantaged, limited-English proficient (LEP) students, and individuals with disabilities. The statute requires that at least half of the applications funded contain a component designed to serve "special needs" children who are also gifted.);
- summer programs, mentoring programs, service learning programs, and cooperative programs with business and industry;
- strengthening state leadership and capacity building for LEA to improve gifted programs; and
- technical assistance, information dissemination, and evaluation.

The statute stipulates that not more than 30 percent of the funds for the Javits Gifted and Talented Education program be set aside for a grant to operate the National Center for Research and Development in the Education of Gifted and Talented Children and Youth. This center (established in 1990) is currently operated by a consortium led by the University of Connecticut at Storrs. Other members include: Stanford University, City University of New York, University of Virginia, and Yale University. These institutions engage in applied research involving collaborative efforts with school districts. The center publishes a periodical that highlights the most recent research available on gifted programs.

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[1] The focus of this report is the federal program. However, most states also provide some support for education of K-12 gifted and talented students. The National Center for Education Statistics (NCES) indicates that 31 states (plus Guam) had state mandated elementary and secondary education programs for gifted and talented students. *Digest of Education Statistics, 1998*, Table 55.

Table 1

Javits Gifted and Talented Education Program Appropriations FY1989-FY2001

Fiscal Year	Appropriation
1989	$7,904,000
1990	9,888,000
1991	9,732,000
1992	9,732,000
1993	9,607,000
1994	9,607,000
1995	4,921,000
1996	3,000,000
1997	5,000,000
1998	6,500,000
1999	6,500,000
2000	6,500,000
2001 (budget request)	7,500,000
2001 (House passed)	7,500,000
2001 (Senate passed)	7,500,000

Federal Funding for the Javits Program

The Clinton Administration's FY2001 budget requests $7.5 million for the Javits Gifted and Talented program, $1 million above the FY2000 appropriation provided through the Consolidated Appropriations Act for FY2000, P.L. 106-113. Table 1 shows funding for the Javits program.

Program Data

Program data indicate that the Javits program funded over 125 grants between 1992 and 1999, that supported model programs for educating gifted students and aided over 2 million gifted students in the last decade. In FY2000, funding was provided for six new grants ($1,075,000), 16 continuation grants ($3,355,000), $1.5 million for the research and development center, $255,000 for conferences and dissemination, and $65,000 for peer review of applications for new awards.[2]

A comprehensive evaluation of the Javits program is being conducted by the Department of Education's Expert Panel on Promising and Exemplary Practices.[3] One draft evaluation of the Javits program emphasizes the positive impact of the Javits program on parents and teachers, as well as improving self-perception and achievement test scores of the gifted students in the program.[4]

Legislative Activity

Hearings were held by the Senate Committee on Health, Education, Labor, and Pensions on June 10,1999 "examining legislation authorizing funds for ESEA programs including Special populations, and S. 505, giving Gifted and Talented students the opportunity to develop their capabilities."

Delineated below are some selected legislative proposals:

S. 505. Senator Grassley. Gifted and Talented Students Education Act of 1999. Introduced March 2,1999. Similar to H.R 637, S. 505 authorizes the Secretary of Education to make grants to states for use by public schools to develop or expand programs for gifted and talented students through activities including professional development, technical assistance, innovative programs, and emerging technologies. The bill sets grant application requirements and provides a state allotment formula using the ratio of the number of school-aged children (ages 5 through 18) in each state to the total number of school-aged children in the U.S. The bill authorizes $160 million for each fiscal year 2000 through 2004.

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[2] For more detailed descriptions of grants, see U.S. Department of Education, *Jacob Javits Gifted and Talented Students Education Program, Javits abstracts*. OERI, 2000.

[3] See U.S. Department of Education, *Biennial Evaluation Report, FY1995-1996*. p. 618.

[4] Callahan, Carolyn. *What Have We Accomplished with the Javits Gifted and Talented Students Education Act? Innovative Programs*. Draft. U.S. Department of Education. Not dated.

H.R. 637. Representative Gallegly, Elton and 55 Cosponsors. Gifted and Talented Students Education Act of 1999. Introduced February 9, 1999. Similar to S. 505. See description of S. 505 above.

H.R. 2. Representative Goodling. Introduced February 11,1999. Ordered reported October 13, 1999 (H.Rept. 106-394) and ***passed by the House October 21,1999***. **H.R. 2** creates Title V, **the Jacob K. Javits Gifted and Talented Students Education Act of 1999**, that would amend Title X-B, ESEA to provide *discretionary* grants and *formula* grants to "build a nationwide capability to meet the special needs of gifted students." Subpart 1 provides discretionary grants for research and development, personnel training and professional development, technical assistance for dissemination, and adaptation of methods and materials for all students (including those from inner cities, rural communities, and low-income families). Half of the applications must serve gifted students who are either economically disadvantaged, limited English proficient, or disabled.

Subpart 2 of **H.R. 2** provides *formula* grants for teacher preparation and other services for the gifted when the annual appropriation first equals or exceeds $50 million. The formula grant would be continued in succeeding fiscal years and *replace* discretionary grants. If and when the formula grant is implemented, a continuation award under the previous current law terms would be given special consideration. Until the $50 million funding level is first reached, the amendments would continue current law's discretionary grant program, adding "scientifically based research" to authorized uses. Formula grants would be allotted to states based on relative population of age 5-17, with 95 percent of funding to LEAs, including charter schools, with 5 percent reserved for state administration. No state would receive less than one-fourth of 1 percent of the total allotment for states. Activities supported by formula grants would include professional development, innovative curriculum development, emerging technologies including distance learning.

Also under **H.R. 2**, Title V maintains the current National Center for Research and Development in the Education of Gifted and Talented Children and Youth, adding the term "scientifically based research" to their agenda, and authorizes $10 million for Subpart 1 or 2 in FY2000 and "such sums as may be necessary" for FY2001-FY2004. For the National Center, the bill authorizes $1,950,000 for each fiscal year 2000 through 2004.

S. 2. Educational Opportunities Act. Senator Jeffords. (Considered in the Senate Committee on Health, Education, Labor and Pensions and ordered reported March 9, 2000, printed April 12, 2000 (S.Rept. 106-261). Title III-C of S. 2 would amend Title X-B ESEA to provide both *discretionary* grants and *formula* grants to meet the special educational needs of gifted students. When the appropriation reaches or exceeds $50 million, funding would be distributed by formula to states. Funds would be allotted to states based on each state's school-age population compared to school-age population of all states, and it includes a state minimum of one-half of 1 percent of allotments. States would be allowed to use 10 percent of funds for administration and application purposes, and 2 percent for statewide parental support programs. The remainder (88 percent) would be allotted to LEAs on a competitive basis. States would be required to fund 20 percent of program costs through non-federal sources.

Under the provisions of **S. 2**, if funds appropriated are less than $50 million then funds would be awarded on a competitive basis according to current law. **S. 2** adds a "Grandfather clause"such that even if the $50 million appropriation is exceeded, the bill would still honor awards for continuation grants to current recipients under the original terms of the grants until they expire, and would still honor multi-year grants or contracts.

S. 2 would retain current law provisions for the National Center for Research and Development in the Education of Gifted and Talented Children and Youth, limiting funding for the National Center to not more than 30 percent of the total appropriation for the Javits program. **S. 2** authorizes $155 million for the Javits Gifted and Talented program for FY2001 and "such sums as may be necessary" for each of the 4 succeeding fiscal years, and authorizes $5 million for the National Center for FY2001 and "such sums as may be necessary" for each of the 4 succeeding fiscal years.

Reviews

Reviewed by Francis Cartier, Ph.D.

Understanding Those Who Create, 2nd edition
By Jane Piirto, Ph.D. Gifted Psychology Press, Inc., Scottsdale, AZ, 1998. Pp.445.

This is an update of the book first published by Ohio Psychology Press in 1992. It has added references as recent as 1998 to its 29-page bibliography.

Piirto wisely begins with an intensive inquiry into the many definitions of *creativity*. My own extensive study of the definitions once led me to the frustrated conclusion that, for research purposes at least, we should apply Ockham's Razor and expunge the term entirely. After all, we nearly always apply the term ex post facto. E.g., she quotes Csikszentmihalyi's position that, "Creativity is any act, idea, or product that changes an existing domain, or that transforms an existing domain into a new one." You see the problem, don't you? Instead of using the present tense, Csikszentmihalyi might have said more clearly, "...that *has observably changed* an existing domain ...."

Piirto comes close to my conclusion that the word creativity is virtually meaningless but, also as finally I did, succumbs to the sometimes-useful illusion that creative thinking is somehow different from real thinking. (My position used to be that real thinking is so rare that, when we observe it, we feel we need to celebrate the occasion with a special adjective: creative.) She also seems to share my concern that the term is often applied indiscriminately to an aptitude as well as to an achievement, which seriously blurs the concept, and that the terms *creative* and *gifted* have been disadvantageously entangled.

> A major concern of the creativity theorists is whether one can be creative without a created product. Logic suggests that without a created product, we cannot conclude that a person is creative; in other words, in order to bejudged creative, one must have created something. But in fact such a nonproduct assessment of creativity is essentially what is done in talent development education when creativity is defined as creative potential and is considered an inherent type of giftedness.

Piirto explores this question, the contribution, if any, of "IQ" to creative accomplishments and nearly all the other past and current issues regarding creativity. She does it very well, indeed. If you have Piirto's book and those of Teresa M. Amabile, whose work Piirto admires, you have about as clear a picture of the state of theory, definitions and research into creativity as you could get. So how does Piirto define it? (the italics are hers):

> *Creativity is in the personality, the process, and the product within a domain in interaction with genetic influences and with optimal environmental influences of home, school, community and culture, gender, and chance. Creativity is a basic human instinct to make that which is new.* While creativity is the natural propensity of human being-ness, creativity can be either enhanced or stifled. The creative personality can be either developed or thwarted.
>
> Creativity takes certain habits of mind. Creativity is not separate from intelligence or artistry, but part of the whole. What is unnatural is for it to be repressed, suppressed, and stymied through the process of growing up and being educated.

Amen, say I, though a lot of those words need to be unwrapped and explained. She does that fairly well later in the book. My own study of creativity, done for the Air Force, was limited to its applications to practical implications for managers and engineers so I was particularly pleased that Piirto includes aesthetic creativity and I hoped to learn something about that aspect as well. I did. However, as engrossing as it was to read the biographies of some great, creative artists, I was disappointed to find that Piirto, like many writers on creativity, haven't fully considered the possibility that explaining creative problem solving may require a totally different definition and theory of creativity than in the arts. Piirto often agrees with Amabile and others that the mechanisms of creativity may be specific to a domain (science, writing, drawing, etc.). Still, she falls into the ancient trap of proposing a single definition covering all domains. She's in good company in that trap. In her Appendix A, she gives thumbnail descriptions, "...as if I were writing a movie blurb for *TV Guide*,"of 73 philosophers, psychologists and other pundits, all but three or four of whom reify the essentially predicative concept of creativity as a single concept.

After Part II, devoted to a fairly thorough description and critique of current tests, questionnaires, checklists and other assessments, Part III delves deeply into the research on personality and intellectual characteristics of visual artists and architects, writers, musicians and composers, actors, dancers and even athletes. Scientists, mathematicians, inventors, and entrepreneurs are not neglected in this review of creativity by domain. Most of this section is anecdotal, but it is both enlightening and makes interesting reading.

Piirto writes beautifully. Her book is intended as a textbook for a university course on the psychology of creativity, presumably for teacher training, but it reads as well as a novel.

Part IV, which begins about four fifths of the way through the book, is titled, "How to Enhance Creativity." Her recommendations are all positive, useful approaches. However, I would have liked to see much more on avoiding and removing the barriers to imaginative thinking. There are many ways in which creative thinking is discouraged and even stifled in both the home and the classroom. Understanding them may be even more important to a parent or teacher than merely encouraging or "enhancing" creativity.

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Despite such minor cavils, this is an excellent book. I'm not the only one who says so. As I near completion of this review, I find a review by Dean Keith Simonton, *Contemporary Psychology: APA Review of Books*, 1999 (Vol. 44, No. 5, pp. 394-5). He found a couple of minor flaws that I didn't, but still gives it very positive marks. Says Simonton, "I know of no recent textbook [on creativity] that is as comprehensive as this one."

If you are the parent of a creative child, or if you are a teacher with some creative children in your classroom, you (and those kids) will profit from your reading it.

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